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THE
AGRICULTURAL LEDGER

No. 8, 1902.

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THE AGRICULTURAL LEDGER.

1902.

(BEING VOL. IX.)

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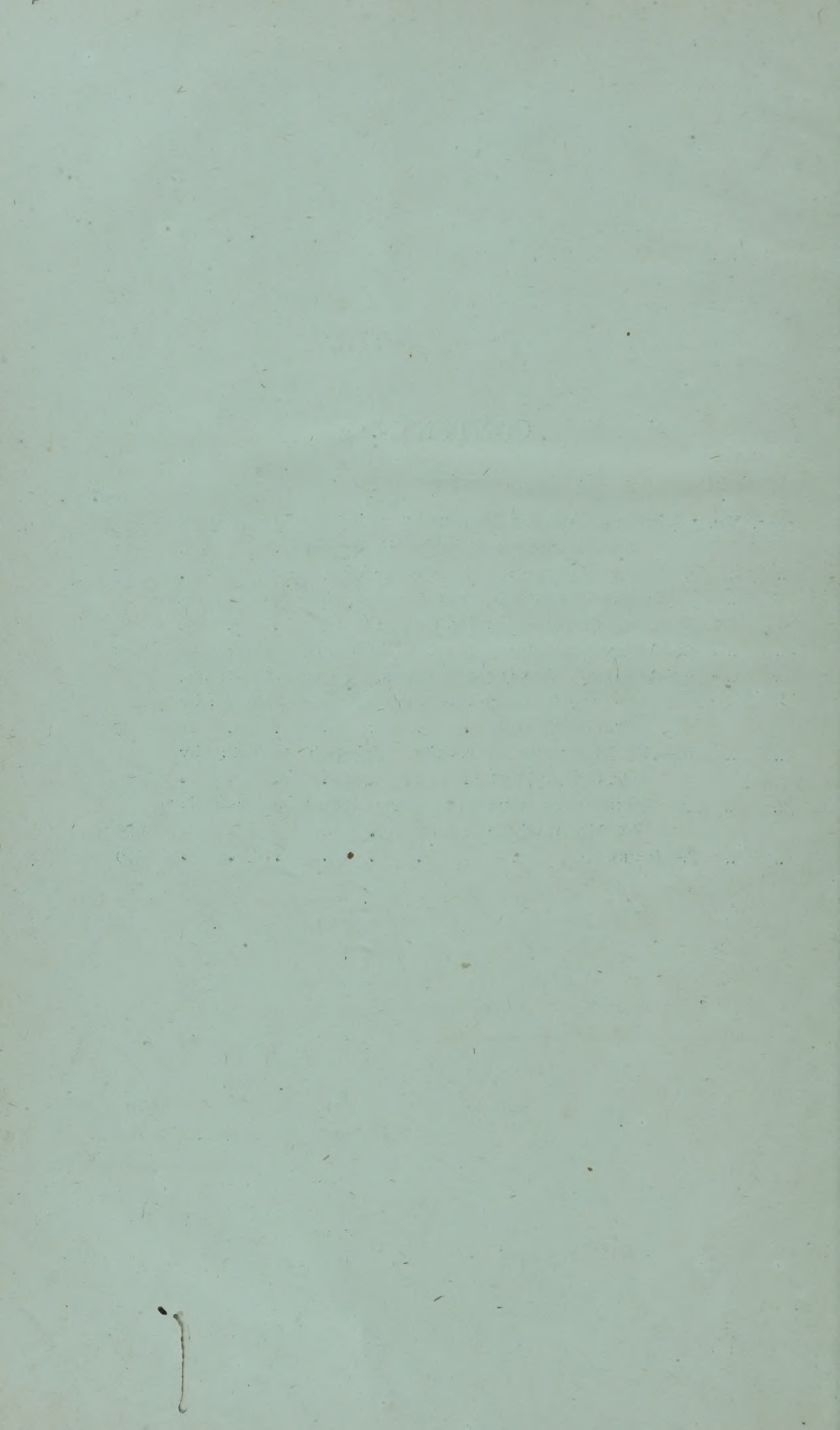
THE REPORTER ON ECONOMIC PRODUCTS TO THE GOVERNMENT OF INDIA,



CALCUTTA:

OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING INDIA.

1903.



NOTE.

To those who bind the *Agricultural Ledger* two alternatives are suggested ; they may bind the issues of each year into an annual volume, or they may keep apart the series into which it is divided.

These Series are as follows :—

- I.—VEGETABLE PRODUCT SERIES.
- II.—ANIMAL PRODUCT SERIES.
- III.—MINERAL AND METALLIC SERIES.
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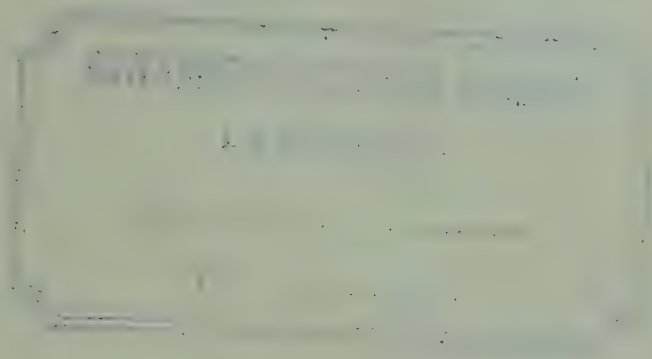
For either purpose indexes will be published. The annual index will continue to appear year by year ; the “serial” indexes will appear at wider intervals.

The annual index refers to the numbering which heads the pages ; the numbering at the foot, which is consecutive in each Series, will be used in the serial indexes.

Public libraries and similar institutions are likely to find the plan of binding in annual volumes the more convenient one.

I. HENRY BURKILL,

*Officiating Reporter on Economic Products
to the Government of India.*



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(Vegetable Product Series, No. 68.)
(Dyes and Tans.)

THE
AGRICULTURAL LEDGER.
1902—No. 1.

INDIAN TANNING MATERIALS.

[*Dictionary of Economic Products, Vol. VI., L. 167-76.*]

A list of the raw stuffs of India which contain tannin, with notes on their composition and the preparation of extracts,
by MR. D. HOOPER, F.I.C., F.C.S.

At present the chief tanning stuffs of India are Myrobalans (the fruits of **Terminalia Chebula**), cutch (an extract of the wood of **Acacia Catechu**), Tarwar bark or Tanners' cassia (**Cassia auriculata**), and Babul bark (**Acacia arabica**). Of these materials myrobalans, of the average of 34 lakhs, are annually exported principally from Bombay, and cutch, valued at 24 lakhs, is annually exported from Burma.

Babul bark and Tanners' cassia are extensively employed in European and native establishments, the former in Northern India and the latter in Central and Southern India. Besides these there are numerous products more or less known occasionally used in local tanneries or by the aboriginal tribes of the country.

The present number of *The Agricultural Ledger* is devoted to the object of bringing together our knowledge of indigenous tans, to foster a trade in the raw materials and to encourage the manufacture of extracts suitable for exporting to Europe or elsewhere. The forests of India are rich in barks and fruits capable of being more extensively used for tanning purposes, and what we require to know is whether they can be obtained in sufficient abundance, whether they are rich enough in tannin, and whether the tannin is of such a character as to warrant their being placed on the market.

INTRODUC-
TION.

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Indian Tanning Materials.

INTRODUC-
TION.
Conference
of 1888.

During the time of the Indian and Colonial Exhibition of London in 1886 a Conference was called to examine new Indian tanning materials and to discuss the prospect of their use in the trade. Specimens were distributed and examined by experts, and more or less favourable reports were received. The results were published with supplementary remarks by the Reporter on Economic Products as an issue (Vol. 1, Part 1 (No. 9), 1888-89) of the selections from the Records of the Government of India, Revenue and Agricultural Department.

Conference
of 1899.

Another Conference was held in 1899 in the Indian Museum, Calcutta, between the Inspector General of Forests and the Reporter on Economic Products, when it was proposed to institute a more systematic enquiry into the tannin products of India. It was decided in the first place to investigate the actual value of the more ordinary raw tanning materials by chemically analysing them, and in the second place to ascertain the composition and trade value of the solid extracts prepared from these products.

Selected
materials.

A list was compiled of trees yielding barks, woods and fruits which were considered suitable for experiment, and these were indented for from localities where they were afforded in more or less abundance. In the case of *sal* (*Shorea robusta*) and *sein* (*Terminalia tomentosa*) specimens of the bark were obtained from three different districts, and were collected from different portions of the tree in order to discover, if possible, the conditions most favourable for the development of tannin in the bark.

Indian Tans
and their
origin.

The following table is an alphabetical list of the scientific names of the trees, the parts used, and the districts supplying the material :—

<i>Acacia arabica</i>	. . .	Bark	. . .	Punjab.
„ <i>Catechu</i>	. . .	Wood	. . .	North-Western Provinces.
„ <i>dealbata</i>	. . .	Bark	. . .	Nilgiris.
„ <i>leucophloea</i>	. . .	„	. . .	Punjab.
<i>Bridelia retusa</i>	. . .	„	. . .	North-Western Provinces.
<i>Bruguiera gymnorhiza</i>	. . .	„	. . .	Bengal.
<i>Cassia auriculata</i>	. . .	„	. . .	Central Provinces.
„ <i>Fistula</i>	. . .	„	. . .	North-Western Provinces.
<i>Casuarina equisetifolia</i>	. . .	„	. . .	Madras.
<i>Ceriops Candolleana</i>	. . .	„	. . .	Bengal.
„ <i>Roxburghiana</i>	. . .	„	. . .	„
<i>Kandelia Rheedii</i>	. . .	„	. . .	„
<i>Pinus longifolia</i>	. . .	„	. . .	North-Western Provinces.
<i>Pterocarpus Marsupium</i>	. . .	„	. . .	Central Provinces.
<i>Rhizophora mucronata</i>	. . .	„	. . .	Bengal.

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(D. Hooper.)

<i>Shorea robusta</i>	.	.	Bark	.	North-Western Provinces, Central Provinces and Assam.
<i>Terminalia Chebula</i>	.	.	"	.	Pegu, Burma.
" <i>tomentosa</i>	.	.	"	.	North-Western Provinces, Central Provinces and Assam.
<i>Xylia dolabriformis</i>	.	.	Wood	.	Pegu, Burma.

ANALYSES
OF TANS.

The analysis of these materials enabled a tabular arrangement to be made showing their value in tanning matter. This is indicated below where the highest percentage is placed first:—

<i>Terminalia Chebula</i>	.	.	.	.	Bark	28.6
<i>Rhizophora mucronata</i>	.	.	.	.	"	26.9
<i>Ceriops Candolleana</i>	.	.	.	.	"	26.2
<i>Cassia auriculata</i>	.	.	.	.	"	23.0
<i>Ceriops Roxburghiana</i>	.	.	.	.	"	19.2
<i>Acacia dealbata</i>	.	.	.	.	"	17.8
" <i>arabica</i>	.	.	.	.	"	16.7
" <i>leucophloea</i>	.	.	.	.	"	16.2
<i>Bruguiera gymnorhiza</i>	.	.	.	.	"	15.9
<i>Bridelia retusa</i>	.	.	.	.	"	15.9
<i>Pinus longifolia</i>	.	.	.	.	"	14.6
<i>Kandelia Rheedii</i>	.	.	.	.	"	12.2
<i>Casuarina equisetifolia</i>	.	.	.	.	"	11.1
<i>Cassia Fistula</i>	.	.	.	.	"	9.5
<i>Acacia Catechu</i>	.	.	.	.	Wood	6.8
<i>Pterocarpus Marsupium</i>	.	.	.	.	Bark	5.4

Most divergent results were obtained from the examination of the special series of *sal* and *sein* barks. In appearance the samples of ***Shorea robusta*** were extremely fibrous, and there was little to enable one to distinguish between the bark from the branches, from the coppice shoots or from the trunks of mature trees. The trees from the North-West Provinces gave a somewhat better outturn than those from the Central Provinces, but a specimen of bark taken in Assam from old branches yielded one quarter the amount of tannin than the bark from fully grown trunks.

The mangrove barks occupy a good position in the list, the percentage of tannin in the extract being very satisfactory.

The extracts of ***Pinus longifolia*** and ***Cassia Fistula***, while proportionately high, are rather low in tannin contents. The large amount of extraneous matter dissolved out of the barks by means of

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Indian Tanning Materials.

REMARKS
ON THE
ANALYSES.

water would render them unsuitable for preparing extracts for the trade.

The composition of the wood of **Acacia Catechu** contrasts rather unfavourably with the richer barks enumerated in the table, but it must be remembered that the most satisfactory extract is obtained from this source. In this instance the result shows that the proportion of active principle in the raw material is not regarded as a criterion by the catch boiler.

It is rather an unexpected result to find that the bark of the Kino tree which yields such an astringent exudation should be an inferior product. It is possible, however, that the younger bark may contain more tannin.

Figures not
absolute.

In all the above analyses, and in others to be quoted further, it must be understood that the figures are not to be taken as absolute. For instance, it would be erroneous to permanently record the statement that **Casuarina** bark contains 11 per cent. of tannin, or that the wood of the Khair tree contains 6·8 per cent. The figures relate only to the identical samples examined during the course of the year, and are useful for purposes of comparison, but they cannot be taken as the standards of tannin value of the products.

Extracts
employed
in Europe.

Quebracho.

It would be instructive to consider the nature of the tannin preparations employed in Europe where the art is in an advanced stage of excellence. An acceptable preparation is the Quebracho extract made from the wood of a Central American tree (**Quebrachia Lorentzii**, *Griseb.*) of the natural order Anacardiaceæ. This extract is light coloured, and forms a superior leather with much body and strength.

Hemlock
Tip.

Another important agent employed very largely is Hemlock wood of America, obtained from **Pinus canadensis**. This material yields from 8 to 10 per cent. of tannin with an insignificant proportion of colouring substances.

Chestnut.

The wood of the Chestnut tree (**Castanea vesca**) is also largely employed. In the consular report on the trade of Cherbourg for 1892, it is stated that the export of the extract of the wood is developing, having reached 150 to 200 tons per month.

Myrobalans.

Of all the materials imported into Germany myrobalans is the cheapest, and its use is yearly extending. The nuts contain on an average 30 per cent. of tannin and the tannin can thus be bought in a form cheaper than any other. The price of the material is calcu-

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(D. Hooper.)

MATERIALS
EMPLOYED
IN EUROPE.

Myrobalans.

Deterioration
of tans.

Requirements
of the
tanner.

lated on the value of one centner (100 pounds) containing 1 per cent. of tannin. Thus, while the unit of oak bark tannin is .59 mark, and fir bark .26 mark, myrobalans is .24 mark ($.24 \times 30$, the percentage of tannin, gives 7.2 marks as the value of the centner of myrobalans). Quebracho wood is worth 4.25 marks per centner, but as this contains only 22.5 per cent. of tannin it is a much more bulky article to deal in, compared with myrobalans. In European tanneries the materials are mixed not only with a view of obtaining a cheap tan, but also to secure a special colour of leather. Myrobalans alone do not give satisfactory results on account of the greenish-yellow colour they produce. Oak bark bears an admixture of myrobalans for the double object of obtaining a cheaper substance and a finer colour. If colour is of no importance myrobalans and quebracho wood form a cheap mixture, and fir (Hemlock) bark is known to considerably improve the colour of myrobalans.

The export of raw materials for tanning depends on the richness in tannin. A large percentage of the active principle does away with the freight of bulky material, and the more highly concentrated the material the better for the trade in the exporting country. On the other hand, it should be carefully noted whether the substance has been prepared or dried so as to prevent deterioration. Tans rapidly deteriorate in a moist state, or when unduly exposed to the air. Quebracho wood when freshly cut and dried contains 20 per cent. of tannin, but after exposure it has been found to yield only 16 per cent. Other instances of tanning substances deteriorating when improperly stored will be found in the remarks under Pyinkado wood, myrobalans, Shorea bark and mangosteen rind.

The tanner requires an almost pure solution of tannic acid in order to convert hide into leather. The employment of gallotannic acid would be an excellent substance to work with, but its cost is prohibitive. Next to it may be placed the various extracts in accordance with the amounts of tannin they contain and their cost; certain materials not of the nature of skin require special extracts. Bleached gall nut extract is particularly serviceable for very light silk. Pine bark in spite of its cheapness has a more limited use in cotton dyeing than oak extract. In the opinion of some experts extract of myrobalans will undoubtedly supersede that of sumach and other poorer tannin materials. It is already employed in most large English dye works with great partiality. Sumach extract on

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Indian Tanning Materials.

NATURE OF
EXTRACTS.

account of its high price and comparative low percentage of tannin must be placed last. The extracts as used in the most modern establishments are bought with a guarantee of their percentage of tannin. On account of the liability of the raw material to undergo change by weathering no such guarantee can be given. The future will see the raw products neglected and the market supplied with tannin extracts, rich in astringent properties, stable in composition, and moderate in value.

Villon's
theory.

Villon holds that pure tannin will not convert hide into leather, the extractive matter always associated with tannin in tannin being essential. He distinguishes between tannin, assimilable extractive, resinoid extractive and inert extractive. The finished leather made without these was in his experience spongy, soft and perishable.

Professor
Procter's
opinion.

Procter says that there is no foundation for the assertion that pure tannin will not make leather. The only difference is the colour, the pure tanned leather is not coloured, but that with sumach and other substances of diluted astringency is coloured, and therefore the former is preferable. The tannin of galls is identical with that of many other tannin materials; it is not a good tannage for sole leather which demands the use of tannin giving solid deposits such as ellagic acid and phlobaphenes which impart firmness.

*The Preparation of Tannin Extracts.*PREPARA-
TION OF
EXTRACTS.

The powder.—The bark or roots to be operated upon should be in a coarsely powdered state. If the pieces are too large, an inch or more in length for instance, the water could not penetrate and extract the soluble matter. On the other hand, a fine powder will allow percolation to take place very slowly, and working in tropical climates, fermentation would ensue before the material is exhausted. The bark might be ground and sifted through a $\frac{1}{4}$ -inch sieve before it is extracted.

The
Apparatus.

The extractor.—The vessel or series of vessels for this purpose should be of a cylindrical or conical shape with a plug of cotton or jute waste at the bottom and the powder packed in not too tightly. Boiling water is not necessary for exhausting most tanning substances. It has been shown by Professors Parker and Procter (*Journ. Soc. Chem. Industry*, Vols. XIV, p. 451, and XVII, p. 1022) that a temperature 100° C. is quite sufficient and a high temperature is liable to increase the amount of colour. The optimum temperature varies with the material, but in most cases it lies between 60° and 90° C.

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(D. Hooper.)

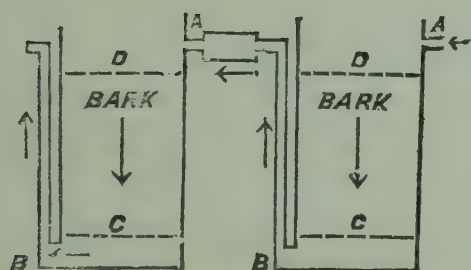
In most Indian barks a temperature of 60° - 70° has been found sufficient.

METHOD OF EXTRACTION.

The best method of extracting barks, etc., is by re-percolation, and a number of experiments were made by Dr. J. W. Leather in Dehra Dun with an apparatus of the following description.

For the extraction of materials soluble in warm water there is no better method than the employment of a series of extractors in which the water gravitates from one to another gradually dissolving more and more of the substance on its way and forming finally a "Concentrated" solution.

A small battery of copper extractors of this description has been fitted up in Dehra Dun. It will be best understood from the annexed diagram which shows two of the series. Each consists of a copper



cylinder, having an inlet pipe A at the top and an outlet pipe B at the bottom at the opposite side, the latter passing up to meet the inlet tube A of the next extractor. In each extractor just above the mouth of B is a false bottom C on which rests the bark, and this is covered by a similar perforated cover D.

Warm water is allowed to pass slowly from one extractor to another, and it issues as a fairly strong solution of the tannin from the last of the series. A battery of 7-9 extractors is usually employed. Gradually No. 1 extractor (into which the water flows) becomes exhausted. When this stage is reached it is taken out of the battery and the water is turned on to No. 2. No. 1 is emptied of its exhausted bark and charged with fresh bark, and it is now attached to (say No. 9) the last extractor of the battery. No. 1 now becomes the last, and when full of liquor, will supply the strongest solution.

This extractor works very perfectly indeed as will be evident from the following figures :—

- (a) Sal bark, 1,200 grams. extracted 2.75 per cent. tannin in bark; therefore 1,200 grams. contained 33 grams. 2,350 c.c. liquor obtained containing 1.37 per cent. tannin, or a total of 32.2 grams.

Results.

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Indian Tanning Materials.

METHODS OF
ANALYSIS.

- (b) 3,100 grams. of **Terminalia tomentosa** bark containing 6.85 per cent., or 212 grams. tannin, yielded liquors which in the aggregate contained 204 grams. tannin.

The apparatus works quite uniformly and would cost but little for fuel if properly constructed for working on the large scale.

*The Concentration of the Liquor.*Concentra-
tion of liquor.

Dr. Leather found that while tannins, when in dilute solution, are not greatly affected by boiling in water at 100°, they are seriously affected when the solution becomes concentrated, and then the amount of colouring matter is also liable to increase. Concentration at diminished pressure *in vacuo* should be resorted to at the later stages, and it is indeed better to avoid a high temperature at any period of the manufacture. Excellent results have been obtained by boiling down the liquor at 40°-45° (pressure 55-90 m.m. mercury) until the liquor contains about 20 to 30 per cent. of total soluble matter.

*The Separation of the Tannins.*SEPARATION
OF TANNINS.

The tannin extracts at present made in Europe are apparently concentrated solutions, rather than solid extracts of tannin, and are transported in casks. Casks would form a considerable item of expenditure in India and therefore it seemed more practical to boil down the extract to a solid state in a vacuum retort.

It was found at an early period of the experiments that in the case of some tannins at least, *e.g.*, *Sal*, **Terminalia tomentosa** and **Cerriops Candolleana**, the tannin is not so soluble in water as is oak bark tannin, and that if the liquors are concentrated until they contain 20-30 per cent. total soluble matter, most of the tannin separates and may be filtered off. **Bridelia retusa** is an instance of a bark whose extract may be concentrated without separation of tannin. The greater portion of the tannins separates in the course of 18 hours and is then filtered. The filtration presents no particular difficulties and the tannin is obtained as a stiff cake. By drying in a vacuum, the time required is from 24 to 48 hours. The material then falls to a dry powder. The extracts thus obtained have up to the present had the following compositions:—

Terminalia tomentosa, 65.9 per cent. and 71.6 per cent. of tannin (Löwenthal).

Cerriops Candolleana, 72.1 and 82.0 per cent. tannin.

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Indian Tanning Materials.

(D. Hooper.)

*The Composition of Tannin Extracts.*COMPOSITION
OF TANNIN
EXTRACTS.

The several tannin extracts which are on the market vary much in composition, not only as regards the proportion of actual tannin, but also in that of "non-tannins" (the matters soluble in water are usually classed as "tannins" and "non-tannins" at present), and in the amount of colour. The value of an extract depends not only on the percentage of tannins present, but it is also depreciated by an unduly high proportion of "non-tannins," and now that a standard is being used to measure the colour, this item will doubtless also influence the price. In the following statement is shown a list of the chief tanning materials used in Europe, with the per cent. of tannins and non-tannins, and their relation to one another, tannin being taken as unity :—

Material.	Per cent. tannin (by hide).	Per cent. non-tan- nins.	Ratio, tannin non-tannin.	Optimum tempera- ture for extraction.
				C.
Belgian oak bark (poor) . . .	9.6	6.1	1 : .63	80—90
Myrobalans (good) . . .	36.0	14.9	1 : .41	90—100
Smyrna Valonia . . .	39.1	17.4	1 : .44	50—60
Greek Valonia . . .	25.0	12.7	1 : .50	60—70
Natal Mimosa . . .	32.0	11.6	1 : .36	70—80
Sumach . . .	20.2	23.1	1 : 1.15	50—60
Quebracho bark . . .	21.7	3.0	1 : .14	80—90
Mangrove bark . . .	21.1	10.8	1 : .51	80—90
Scotch Larch bark . . .	17.8	9.6	1 : .54	60—70
Divi Divi . . .	46.1	25.0	1 : .54	50—60
Algarobilla (Cæsalpinia brevi- folia) . . .	45.7	23.6	1 : .51	20—30
Smyrna Valonia . . .	36.7	15.1	1 : .41	90
Canaigre root . . .	24.6	13.7	1 : .56	40—50
" 3 years old . . .	30.6	14.8	1 : .48	...
Gambier "cube" . . .	60.0	23.0	1 : .38	98
" "block" . . .	50.0	27.8	1 : .55	...
Pine bark . . .	16.5	13.0	1 : .78	80—90
Quebracho extract . . .	70.0	4.6	1 : .06	90
Oak wood . . .	4.3	2.6	1 : .60	90
Oak wood extract . . .	27.6	15.5	1 : .56	...
Chestnut " . . .	29.6	9.0	1 : .30	60—80
Hemlock " . . .	26.6	13.0	1 : .49	...

It will be apparent that the proportion of non-tannins varies from about .30—.50 for each one part of tannin and therefore this proportion should not be exceeded if a high quality of extract is aimed at.

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 Indian Tanning Materials.

COMPOSITION
OF TANNIN
EXTRACTS.

The sal extracts from the Forest School contained too large a proportion of non-tannins, those from **Terminalia tomentosa** were much better (average ratio 1 : .40), but the colour was dark.

Of the extracts prepared in the Dehra Dun Laboratory, that from **Shorea robusta** was not considered a fair specimen, as it was damaged during the concentration. Those from the barks of **Cerriops Candolleana** and **Terminalia tomentosa** had a good colour and would probably stand well in the market.

But it will be necessary to consider each material on its own merits. The bark of **Terminalia tomentosa** and **Cerriops Candolleana** yield little else but tannin to warm water, whilst the liquor from sal bark contains about 1.25 non-tannins to 1 of tannin, and **Terminalia belerica** 3 of non-tannins to 1 of tannin. In these latter cases it would be naturally more difficult to obtain a high class extract than in the former.

*Decolourising Tanning Extracts.*METHODS OF
REMOVING
COLOURING
MATTER.

There are various methods employed for removing the colouring matter of tannin extracts, chemicals and albuminous agents being chiefly used.

A. Villon's method is thus described :—The extract is prepared in the usual way using six vats and a current of carbonic acid at a temperature of 80° to 90°, this is cooled in ordinary settling vats, the liquor drawn off, 0.5 per cent. of zinc sulphate added, the temperature is then maintained for half an hour at + 2° by means of a refrigerating vat similar to those used in breweries; the precipitated impurities are separated in a filter press. The filtrate is transferred to a closed vat provided with a mechanical agitator; a solution of zinc sulphate is then added in the proportion of 2.5 kilos. of the salt per kilo. of tannin present and a current of ammonia gas (obtained by decomposing 2.5 kilos. of ammonium sulphate per kilo. of tannin) is passed in, and the whole heated to boiling; the excess of gas is collected in another vat. Tannate of zinc is thus precipitated and ammonium sulphate is left in solution, the former is separated in a filter press washed with warm and cold ammoniacal water, suspended in five times its volume of water and decomposed with dilute sulphuric acid. A solution of barium chloride is now added and the precipitate consisting of barium sulphate and zinc sulphate is removed by filtration, and an almost colourless liquid is thus obtained containing 20-30 per cent. of tannin quite free from extractive matter.

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(D. Hooper.)

Another process devised in 1890 by Landini, Hamburg, is by treatment with nitrate of lead and the subsequent use of alum and borax. The nitrate of lead is added to the boiling solution of tannin in small quantities at a time and with continual agitation until the decolouring is complete. The solution is then withdrawn, cooled down, neutralised and filtered.

PURIFYING
EXTRACTS.

Landini's
method.

An oak wood extract is made by converting the tannin into an acetyl compound, and then heating with water, neutralising and filtering.

A substance called "converted tannin" is made by treating a liquid extract with ammonia and then precipitating with sulphuric acid. This process removes some colouring matter, but is liable to change or decompose the tannin.

Converted
tannin.

Mr. J. B. F. Roy, Paris, removes the impurities of extracts by precipitating with potassium or sodium ferrocyanide, in proportion of 200 to 600 grains to the hot extract resulting from 1 ton of spent wood. He considers the method of purification by mean of metallic oxides objectionable.

Roy's method

Messrs. Morand, of Philadelphia, have devised the following process for obtaining colourless extracts. The wood or bark is cut by machine across the grain and placed in tanks with false bottoms and percolated with water containing small quantities of hydrochloric or sulphuric acid. The concentrated liquor is treated with an alkaline solution of casein, containing 1 part of sodium carbonate and 50 parts of casein, which carries down all impurities. I have experimented with this process and found that casein suitable for this purpose is supplied by Mr. Keventer, of the Dairy Farm, Aligarh.

Morand's
method.

Cinchona alkaloids are known to precipitate tannin matters from solution, but if added in very small quantity at first the colouring matter is removed, and further addition of the alkaloid completely precipitates the tannin. A method has been suggested for separating the colouring matter by means of a solution of an alkaloidal salt. Some experiments have been made in the Economic Laboratory, Indian Museum, in clarifying tannin extracts with alkaloidal salts, and some very satisfactory results were obtained by employing the cinchonine and amorphous alkaloids left as a residue in quinine manufacture. Febrifuge or mixed alkaloids of cinchona bark may also be used, and a solution ready for precipitating the colouring matter is made by dissolving the powder in dilute hydrochloric acid and neutralising while hot with caustic soda.

Experiments
with cinchona
alkaloids.

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CLASSIFICA-
TION OF
TANNINS.

The classification of the tannins, mostly of Indian origin, has been thus summarised by Professor H. R. Procter (*Leather Industries*, 1898, p. 77).

Catechol tannins.

Abies canadensis	.	.	.	.	Hemlock bark.
„ excelsa	.	.	.	.	Larch extract.
Acacia Catechu	.	.	.	.	Wood and bark.
„ leucophloea	.	.	.	.	Bark.
Cassia auriculata	.	.	.	.	„
Ceriopis Candolleana	.	.	.	.	„
„ Roxburghiana	.	.	.	.	„
Larix europæa	.	.	.	.	Larch bark.
Osyris compressa	.	.	.	.	Leaves.
Pterocarpus Marsupium	.	.	.	.	Kino.
Quercus Ilex	.	.	.	.	Bark.
„ other species	.	.	.	.	„
Rhizophora Mangle	.	.	.	.	Mangrove bark.
Soymida febrifuga	.	.	.	.	Bark.
Terminalia Oliveri	.	.	.	.	„
Uncaria Gambier	.	.	.	.	Extract of leaves.

Pyrogallol tannins.

Acacia arabica	.	.	.	.	Pods.
Cæsalpinia coriaria	.	.	.	.	Divi divi.
Punica Granatum	.	.	.	.	Root.
Quercus infectoria	.	.	.	.	Aleppo galls.
Rhus Coriaria	.	.	.	.	Sumach leaf.
Terminalia Chebula	.	.	.	.	Myrobalan.

Doubtful or mixed tannins.

Acacia arabica	.	.	.	.	Bark.
„ sp.	.	.	.	.	Wattle bark.
Pistacia Lentiscus	.	.	.	.	Leaves.
Quercus Robur	.	.	.	.	Oak bark.
Rhus Thunbergii	.	.	.	.	Kliphaut bark.
Rumex hymenosepalus	.	.	.	.	Canaigre root.

CHEMISTRY
OF TANNIN
MATERIALS.

Mr. Perkin's
researches.

An article on tanning substances would be incomplete without reference to the chemical investigation of Mr. A. G. Perkin of the Research Laboratory, Yorkshire College, Leeds. Mr. Perkin has separated and examined the colouring matters of several vegetable tanning matters which have been proved by subsequent experiments to be the source of the dyeing properties of the plants. There has been shown to be a very intimate relationship between the colouring principles and tannin matters occurring together in the plants, in that, on L. 167-76.

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CHEMISTRY
OF TANNIN
MATERIALS.

decomposition, the same acid, and in some cases, the same phenol, is obtained from both.

	Tannin.	Decomposition prod. of tannin.	Colouring matter.	Decomposition prod. of col. matter.	Colouring matters.
Quebracho . . .	Quebracho- tannic acid.	Phloroglucinol and proto catechuic acid.	Fisetin .	Resorcinol and proto catechuic acid.	
Rhus Coriaria . . } " Cotinus . . }	Gallotannic acid.	Gallic acid .	Myricetin .	Phloroglucinol and gallic acid.	
Cambier Catechu . } Acacia Catechu . }	Catechin .	Phloroglucinol and proto catechuic acid.	Quercetin .	Phloroglucinol and proto cate- chuic acid.	
Colpoon compressum .	A catechol tannin.	Proto catechuic acid.	Do. .	Phloroglucinol and proto cate- chuic acid.	
Divi divi . . .	Ellagitannic acid.		Ellagic acid.		

The *seeds* and *fruits* of certain tanning plants yield as a rule ellagic or ellagitannic acid as the colouring matter. The list includes "Valonia," the acorn of *Quercus Ægilops*; Divi divi, the pods of *Cæsalpinia coriaria*; myrobalans, the unripe fruit of *Terminalia Chebula*; Algarobilla, the pods of *Cæsalpinia brevifolia*; Pomegranate rind (*Punica Granatum*), and Gallnuts (*Quercus infectoria*).

The *flowers*, *leaves* and *stems* of plants used for dyeing and tanning contain members of the quercetin groups of colouring matters, with the exception of Persian berries which contain rhamnetin and quercetin, and parsley seeds in which apiin is present.

Classification of Indian Tanning Materials.

The following classification is made according to the vegetable kingdom and illustrates to some extent the distribution of tannin in the Indian flora. The advantage of this arrangement is shown in pointing out where a similar tannin principle is present in one natural order. The list includes all the latest determinations of Professors Hummel, Procter, and Dunstan, and Dr. J. W. Leather. The writer is responsible for the unauthenticated results recorded in the text, many of the analyses having been performed in the Chemical Laboratory of the Economic and Art Section of the Indian Museum.

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TAMARIX
GALLICA,

TAMARICACEÆ.

Tamarix gallica, Linn.*T. atriculata*, Vahl.*T. dioica*, Roxb.

The galls of these species contain as much tannic acid as oak galls (about 50 per cent.), and are readily purchased by manufacturers when offered for sale in Europe. The price in Bombay (1890) is Rs 12 to 13 per maund of 37½ lbs.

The leaves of *T. gallica* yield ellagic and gallic acid and the colouring matter contains a quercetin monomethyl ether (*A. G. Perkin*, 1898).

Leaves.

Professor Procter found in the leaves:—Tanning matter, 8·4; soluble non-tannins, 26·7; insoluble at 60°F., 57·7; water 7·2 per cent. The leaves were collected in November; probably the tannin content would be greater if they were procured in June to August.

Bark,

A sample of the bark afforded:—Tannin, 7·7; extract, 19·1; water 10·82; ash, 10·34 per cent. Baden Powell states that the ashes of the bark of this shrub contain a large proportion of sodium sulphate. Of the 10·34 per cent. of ash examined above, only 1·53 parts could be reckoned as sodium sulphate.

GUTTIFERÆ.

GARCINIA
MANGOS-
TANA.*Garcinia Mangostana*, Linn. (*Dict. Econ. Prod.*, G. 58).

The Conservator of Forests, Pegu, called attention in 1896 to the quantity of husks of this fruit thrown away in Moulmein, Tavoy, Margui and the southern parts of Tenasserim, as well as in Penang and Singapore. It occurred to him that something should be done with the raw product which comes into season in April. The fresh fruit rind makes an indelible stain on the skin, and is highly astringent. The husks examined by the Agricultural Chemist of India were found to yield less than one per cent. of tannin and very little colouring matter. They had been dried carelessly and were decomposed. The rind of the Mangosteen fruit, carefully dried, is said to contain about one-third of its weight of tannin.

MESUA
FERREA.*Mesua ferrea*, Linn. (*Dict. Econ. Prod.*, M. 500).

The brown hard pericarps of the fruit of this tree are highly astringent.

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TERNSTRÆMIACEÆ.

Camellia Thea, *Link.*

The leaves of the Tea bush contain about one-fifth of their weight of tannin, and are used as a domestic dyeing and tanning agent. The tannic acid gives a blue-black colour with ferric chloride, and is changed into an insoluble anhydride by the action of acids.

DIPTEROCARPACEÆ.

Dipterocarpus tuberculatus, *Roxb.* (*Dict. Econ. Prod.*, D. 698 a).

DIPTEROCAR-
PUS TUBER-
CULATUS.

An extract prepared in 1898 in Pyinmana Division, Burma, from the bark of this tree, previously cut into chips, afforded 24 per cent. of soluble tannin. A considerable amount of the original tannin had become insoluble (phlobaphene) during the course of preparation. An evaporated decoction prepared in the Western Circle, Burma, left a soft extract yielding 8·8 per cent. of tannin calculated on the dried product.

Shorea robusta, *Gaertn.* (*Dict. Econ. Prod.*, S. 1660).

SHOREA
ROBUSTA.

Sal bark. In January 1888 Captain E. S. Wood, Conservator of Forests, North-Western Provinces and Oudh, addressed the Inspector General of Forests on the utilisation of sal and asaina bark as commercial tanning materials. The entrance of railways into the forests would necessitate the cutting of a thousand acres of coppiced tree, and as this was a matter of considerable importance to the interests of the Forest Department, it was suggested that practical experiments should be made to prepare extracts from the barks, and employed in the same way as hemlock extract is used in America and Europe.

First
experiments.

An extract of sal bark was made by Mr. B. A. Rebsch in 1886 under instructions of Captain Wood, first in a liquid state and afterwards in a dry state, with a view to see if it could be utilised in the leather trade. The yield of extract was about 8 per cent. The amount of tannin found by Mr. W. N. Evans in 1887 was 32·29 per cent. The colour of the solution made by the extract was rather unfavourable, but judging from its strength it was about equivalent to chestnut wood extract which was selling from £12 to £15 per ton.

Poor in
tannin.

More recent experiments have shown that the bark of the sal tree does not contain a very large quantity of tanning matter. A sample from the Singbhum Division for instance gave only 4·3 per

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cent. tannin, and three extracts made at different times in this division yielded 26, 36 and 39 per cent. of tannin, with an average of 16 per cent. of insoluble matter.

A solid extract from bark from Saharanpur made in 1897 afforded 26 per cent., and in two extracts prepared in Dehra Dun from bark from the Tista Division contained 29 and 49 per cent., respectively. The following tannin contents were separated from extracts prepared from different kinds of bark obtained from Dehra Dun Division :—

Bark from old tree.	From young tree.	Chips.	Branches from old tree.	Old branches.		
35·4	33·9	33·5	31·5	30·5	30·7	27·0

**VATERIA
INDICA.**

Vateria indica, Linn.

A sample of the fruit of this tree contained 25 per cent. of tannin, with only 12 per cent. of soluble non-tannin matters. This fruit might yield a valuable extract, comparatively free from colouring matter (*Leather*).

The bark is used in Ceylon to control fermentation in toddy for arrack manufacture—a property which resides in various astringent materials.

MALVACEÆ.

**THESPSIA
POPULNEA.**

Thespesia populnea, Corr. (Dict. Econ. Prod., T. 396).

The bark and wood contain tannin and a fine red colouring matter.

STERCULIACEÆ.

**HERITIERA
LITTORALIS.**

Heritiera littoralis, Dryand. (Dict. Econ. Prod., H. 138).

The bark of this plant, from a sample examined by Dr. Busse in 1898 from German East Africa, contained 14 per cent. of tannin. It was reported to be remarkably free from colouring matter.

TILIACEÆ.

**PENTACE
BURMANICA.**

Pentace burmanica, Kurz. (Dict. Econ. Prod., P. 390).

This tree is very plentiful in Lower Burma, where it is known as *Thitka*. The Burmans in Tenasserim and Mergui prefer to eat the bark of this tree with betel leaf instead of cutch, and native doctors use the bark in cases of diarrhoea and dysentery. In July 1899 Mr. F. B. Manson forwarded to the Reporter on Economic Products a sample of extract prepared from the bark of *Thitka* by Mr. Hearsey, the Divisional Forest Officer of South Tenasserim. Several hundred

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viss of bark is obtainable from one tree, and the cutch-like extract is easily manufactured. Some pieces of cloth dyed with the extract compared favourably with some dyed with cutch made from **Acacia Catechu**. The extract was approved locally.

A sample of the extract was examined by Dr. B. H. Paul with the following results:—Tannin, 33·9; non-taninns, 13·5; insoluble 8·3; water 44·3. The extract was reported to be too moist for commercial purposes, and contained insoluble matter. Ordinary cutch is known to give no appreciable amount of residue in boiling water. The colour of the extract was intensely red, and the dye test was similar to that of mangrove cutch of the "Tuan" brand.

MALPIGHIACEÆ.

Hiptage Madablota, Gaertn. (*Dict. Econ. Prod.*, H. 286).

HIPTAGE
MADABLOTA.

A sample of this bark from the Madras Forest Department, sent as a tanning material, was found to contain 8·5 per cent. of tannic acid giving a greenish colour with iron salts.

GERANIACEÆ.

Averrhœa Carambola, Linn. (*Dict. Econ. Prod.*, A. 1651).

The unripe fruits are astringent, and are used as an acid in dyeing, the acid probably acts as a mordant.

Geranium nepalense, Sweet (*Dict. Econ. Prod.*, G. 178).

GERANIUM
NEPALENSE.

The roots of Indian Geraniums, in common with those of other plants of this order, *e.g.*, **Pelargonium** and **Monsonia**, have very astringent properties. According to the experiments of Messrs. Trimble and Peacock in 1891 with the roots of **G. maculatum** it would appear that gallotannic acid is present in largest amount in April just before the plant blooms, and rapidly decreases until it reaches a minimum in October; thus pointing to the possibility of its being a storage material to assist the plant in flowering and perfecting its seed.

The root is an article of commerce in Kashmir where it is reported to be used as a dye. Recent investigations, however, point to the conclusion that it is more suitable as a tanning agent. The roots from Kashmir are cylindrical and shrivelled, about 3 to 4 inches in length, brown in colour, with a reddish-brown, close fracture. A section of the root shows a ring of yellowish detached wood-wedges

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GERANIUM
WALLICHIA-
NUM.

midway between the circumference and pith. A sample from this district yielded as much as 43·5 per cent. of tannic acid and insoluble phlobaphene (geranium red), and a sample from Saharanpur, consisting of smaller fibrous roots, afforded 10·8 per cent. of tannin.

Geranium Wallichianum, *D. Don. (Dict. Econ. Prod., G. 185).*

This species like the former yields a root said to be sold as a dye stuff in Kashmir. A sample was examined in 1895 by Professor H. R. Procter, of Leeds, with the following results :—Tanning matter 25·7; soluble not tanning matter, 17·8; fibre and insoluble, 43; moisture 13·5. Leather produced by this root was somewhat darker but not very dissimilar to that obtained by the use of canaigre root (*Rumex hymenosepalus*). A sample of root gathered in Mussoorie gave 32 per cent. of tannin.

Professor Hummel, reporting on the dyeing properties of this material, says :—“The dark grey given by the iron mordants, and the pale soiled yellowish tint on the aluminium mordants show that these roots contained essentially tannin matter, unaccompanied by any mordant dyeing colouring matter for which cotton has a natural attraction.” Its dyeing powers were similar to sumach and myrobalans (*see Agricultural Ledger, No. 6, 1901*).

RUTACEÆ.

ÆGLE
MARMELOS.

Ægle Marmelos, *Corr. (Dict. Econ. Prod., A. 537).*

The fruit of the Bael tree is known to be slightly astringent. The pulp has been found to contain about 9 per cent., and the fruit shell 20 per cent. of tannin (*Leather*). The unripe fruit is used with myrobalans in calico printing.

SIMARUBACEÆ.

AILANTHUS
EXCELSA.

Ailanthus excelsa, *Roxb. (Dict. Econ. Prod., A. 660).*

The bark contains no tannin (*Agricultural Ledger, No. 25 of 1896*).

AILANTHUS
GLANDU-
LOSA.

A. glandulosa, *Desf.*

Ellagic acid was found in the leaves. The colouring matter is quercetin and the tannin gallotannic acid. Professor Procter found :—Tanning matter 11·2; soluble non-tannins 20·4; insoluble at 600° F. 60; water 8·4. It is of little utility for tanning purposes and a
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deleterious substitute for sumach (*A. G. Perkin, Journ. Chem. Soc., 1898, 374*).

BURSERACEÆ.

Garuga pinnata, *Roxb. (Dict. Econ. Prod., G. 145.)*

GARUGA
PINNATA.

The bark is used for tanning (*Brandis, Gamble*). A decoction prepared in Coorg and sent as a tanning agent was very astringent.

MELIACEÆ.

Amoora Rohituka, *W. and A. (Dict. Econ. Prod., A. 990.)*

AMOORA
ROHITUKA.

The bark is a useful astringent.

Carapa moluccensis, *Lam. (Dict. Econ. Prod., C. 485.)*

CARAPA
MOLUC-
CENSIS.

This bark is the *Granatum littoreum* of Rumphius, and is bitter and astringent. Dr. Busse obtained 35.2 per cent. of tannin as an average of three estimations of barks from East Africa.

Cedrela Toona, *Roxb. (Dict. Econ. Prod., C. 842.)*

CEDRELA
TOONA.

The bark contains a considerable quantity of tannin which produces a purplish leather. (*Fawcett.*) It is occasionally used for tanning in India.

Chickrassia tabularis, *A. Juss. (Dict. Econ. Prod., C. 1024.)*

CHICKRASSIA
TABULARIS.

The bark is a powerful astringent.

Soymida febrifuga, *A. Juss. (Dict. Econ. Prod., S. 2501.)*

SOYMIDA
FEBRIFUGA.

A sample of the bark contained 12.9 per cent. of tannin associated with a high amount of non-tannins. It produces a light coloured leather.

Walsura piscidia, *Roxb. (Dict. Econ. Prod., W. 13.)*

WALSURA
PISCIDIA.

The bark contains a large quantity of tannin giving a greenish black colour with iron salts.

CELASTRACEÆ.

Elæodendron glaucum, *Mrs. (Dict. Econ. Prod., E. 76.)*

ELÆODEN-
DRON
GLAUCUM.

The most remarkable property of this bark is its astringency. It affords about 8 per cent. of tannin giving a dark green with iron salts.

RHAMNACEÆ.

Rhamnus Wightii, *W. and A. (Dict. Econ. Prod., R. 164.)*

RHAMNUS
WIGHTII.

Bark from a young tree from the Nilgiris afforded 26 per cent. of tannic acid.

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**ZIZYPHUS
JUBA.****Zizyphus Jujuba**, *Lamk. (Dict. Econ. Prod., Z. 234).*

A sample of bark from Madras gave 4·1 per cent. of tannin coloured blue black with ferric salts.

The roots vary in the amount of astringency. A sample of thick roots examined at Dehra Dun yielded only 2·6 per cent. of tannin, while some thin roots afforded 9·3 per cent. In the latter sample the tannin was accompanied by 0·71 per unit of non-tannin matter, and the amount of colour was not excessive.

**ZIZYPHUS
NUMMU-
LARIA.****Zizyphus nummularia**, *W. and A. (Dict. Econ. Prod., Z. 255).*

The bark is used as a tan in the Punjab.

**ZIZYPHUS
VULGARIS.****Z. vulgaris**, *Lamk. (Dict. Econ. Prod., Z. 283).*

A sample of this bark from the Madras Presidency gave 2·8 per cent. of tannin with a large proportion of non-astringent soluble matter.

**ZIZYPHUS
XYLOPYRUS.****Z. xylopyrus**, *Willd. (Dict. Econ. Prod., Z. 292).*

The 7·2 per cent. of tannin found in a sample of bark examined at Dehra Dun was accompanied by a large proportion of non-astringent substance, and would not therefore be suitable for preparing a tanning extract.

The fruits afforded 10 per cent. of tannin (*Leather*).

SAPINDACEÆ.**SCHLEI-
CHERA
TRIJUGA.****Schleichera trijuga**, *Willd. (Dict. Econ. Prod., S. 955).*

A watery extract prepared from the bark in Coorg was found to be very astringent. A sample of the bark from Bombay contained 9·4 per cent. of tannin, striking a greenish colour with iron salts.

**BALANITES
ROXBURGHII.****Balanites Roxburghii**, *Planch. (Dict. Econ. Prod., B. 17).*

The fruit of this tree is called Egyptian myrobalans, but it is not astringent. It has detergent properties and contains saponin.

ANACARDIACEÆ.**ANACARDIUM
OCCIDEN-
TALE.****Anacardium occidentale**, *Linn. (Dict. Econ. Prod., A, 1017).*

The bark is astringent and may be used for tanning.

**BUCHANANIA
LATIFOLIA.****Buchanania latifolia**, *Roxb. (Dict. Econ. Prod., B. 948).*

The bark is used for tanning in Travancore.

A decoction of the bark prepared in Coorg was rich in tannic acid.

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(D. Hooper.)

Mangifera indica, Linn. (*Dict. Econ. Prod.*, M. 190.)

MANGIFERA
INDICA.

The bark, leaves and kernels of the mango are astringent. A sample of bark obtained from Madras afforded 16·7 per cent. of tannin, striking a blue-black colour with ferric salts.

The kernels contain between 8 and 9 per cent. of tannin and are often used in native medicine for diarrhœa and dysentery.

Odina Wodier, Roxb. (*Dict. Econ. Prod.*, O. 40).

ODINA
WODIER.

A sample of bark from Madras afforded 9·1 per cent. of tannin giving a greenish-black colour with ferric salts.

Pistacia integerrima, Stewart (*Dict. Econ. Prod.*, P. 834).

PISTACIA
INTEGER-
RIMA.

The galls (*Kakrasingi*) contain 75 per cent. of tannic acid, giving a blue-black colour with ferric chloride, and yielding protocatechuic acid when fused with caustic potash (*J. G. Prebble*).

Pistacia terebinthus, Linn., var. **mutica**, Ait. et Hemsl.

PISTACIA
SPP.

The galls and leaves of this tree are valuable tanning materials and are imported into Bombay from Persia.*

The yellow colouring matter is myricetin (*A. G. Perkin*).

Pistacia vera, Linn. (*Dict. Econ. Prod.*, P. 861).

The galls (*gul-i-pisteh*) contain about half their weight of tannic acid, and a small quantity of oleo-resin to which their odour is due.

Rhus Cotinus, Linn. (*Dict. Econ. Prod.*, R. 297).

RHUS
CONTINUS.

The leaves and bark are used for tanning. The tree is related to the Sicilian or Venetian Sumach (**Rhus Coriaria**). The colouring matter is due to fisetin.

Rhus paniculata, Wall. (*Dict. Econ. Prod.*, VI., Pt. I., B. 309).

RHUS
PANICULATA.

Vern.—*Bye-gyin* (Burm.).

A small tree, common in Lower Chindwin Division, Burma. Its trunk seldom exceeds six inches in diameter. It grows in all dry forests both in "indaing" (*i.e.*, forests mainly composed of **Dipterocarpus tuberculatus**, **Shorea obtusa**, Wall., **S. siamensis**, *Miq.*, and other species) and also in mixed forests containing teak, **Xylia dolabriformis**, bamboo, etc. Mr. H. Jackson, Deputy Conservator of Forests, who forwarded the bark and preparation made from it, as also botanical specimens of the plant, informs us that a red dye is extracted from the bark and is used for dyeing

*The leaves are affected by a flat horseshoe-shaped gall extending round the margin of the leaf; the leaves so resemble the lobe of the ear that they are called *goshwara*.

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cotton. Kliphaut bark from *Anaphrenium argenteum*, *E. Mey.* (*Rhus Thunbergii*, *Hook.*) is used as a tanning material in the Cape of Good Hope.

The liquid extract evaporated to dryness contained 82 per cent. of tannin. The bark of *Bye-gyin* examined in the Economic Laboratory, Indian Museum, had the following composition:—

Moisture	.	.	.	.	.	.	.	12'1
Tannin	.	.	.	.	.	.	.	21'6
Water extract	.	.	.	.	.	.	.	25'0
Ash	.	.	.	.	.	.	.	8'1

Rhus succedanea, *Linn.* (*Dict. Econ. Prod.*, *R.* 323).

The leaves contain about 20 per cent. of tannin.

Rhus mysorensis, *Heyne* (*Dict. Econ. Prod.*, *R.* 305).

The bark afforded 26 per cent. of total soluble matter extracted by water at a temperature between 85° to 90°, and of this 15'74 consisted of tannic acid—(*Leather*, 1899). It is said to give a splendid buff or brown colour to leather.

Rhus punjabensis, *Stewart* (*Dict. Econ. Prod.*, *R.* 316).

The leaves contain about 13 per cent. of tannin.

Semecarpus Anacardium, *Linn.* (*Dict. Econ. Prod.*, *S.* 1045).

The bark of the marking nut tree is a useful astringent.

Spondias mangifera, *Willd.* (*Dict. Econ. Prod.*, *S.* 2653).

The bark is astringent and is used in Coorg as a tanning material.

CORIARIACEÆ.

Coriaria nepalensis, *Wall.* (*Dict. Econ. Prod.*, *C.* 1961).

All parts of the plant are rich in tannin. The leaves contain 20 per cent. of this principle.

LEGUMINOSÆ.

Acacia arabica, *Willd.* (*Dict. Econ. Prod.*, *A.* 103).

Babul bark is very astringent, and is one of the indigenous tanning substances most extensively used in the country. It is not so rich in astringent matters as the wattle bark of Australia, but it produces a similar coloured leather which is much appreciated. Dr. Leather obtained 16'4 per cent. of tannin and 5'8 per cent. of soluble non-tannins in a sample of this bark received from the Punjab, while the writer obtained 16'7 per cent. of tannin. The tannin

Indian Tanning Materials.

(D Hooper.)

content undoubtedly increases with the age of the tree. So long ago as 1845, Mr. J. Teil, an experienced tanner residing at Kidderpore, writing to Dr. Wallich, remarked "Babul bark taken from a full-grown tree is found to be more astringent and better adapted for tanning purposes than the bark taken from a young tree." **Acacia** barks form admirable substitutes for oak bark and are employed in both European and Native tanneries. **Acacia arabica** bark has also been recommended as a substitute for oak bark in the Indian and Colonial Addendum to the British Pharmacopœia.

The pods of the *babul* yield from 5 to 20 per cent. of tannin according to their maturity, the younger pods being more tanniferous than mature ones. The tannin is of a different nature to that of the bark in that it consists of gallotannic acid and is associated with a large proportion of saccharine and other inert matter. The Berlin Leather Trades Association in 1886 reported that the pods communicate a light grey colour to sheepskin.

Samples of the extract of babul bark and pods were made at Dehra Dun and forwarded to Messrs. Schonbank and Sons, of Berlin, for analysis and opinion as to their trade value.

They contained the following constituents:—

	Bark.	Pods.
Tanning agents	30.0	22.8
Non-tanning soluble substances	24.4	34.1
Insoluble	6.2	8.4
Water	39.4	34.7
TOTAL	100.0	100.0

These extracts were reported to be too highly coloured for the European market. The proportion of non-tanning soluble substance is also too large as they contain from 24.4 to 34.1 per cent. as compared with 2.4 to 13.7 per cent. in the extracts used in the trade.

Acacia dealbata, Link. (*Dict. Econ. Prod.*, A. 212 and 272).

- „ **decurrens**, Willd.
- „ **melanoxylon**, R. Br.
- „ **pycnantha**, Benth.

These trees afford the Wattle barks of Australia.

The Australian acacias or wattles introduced in the Nilgiri Hills many years ago have firmly established themselves, but nothing seems to be done, as in Australia, in collecting the bark as a

ACACIA
ARABICA.

ACACIA
spp.

Wattle
barks.

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AUSTRALIAN
ACACIAS.

commercial article. They also grow well at Newara Eliya, Ceylon. It is true that the common forms of wattle—**A. melanoxylon** and **A. dealbata**—are more plentiful on the hills than those species—**A. decurrens** and **A. pycnantha**—which yield rich tanning barks, but wherever the better species have been planted they have grown vigorously and well, and the bark is equally rich in tannin as that from trees growing in Australia. The price of good wattle bark is £10 per ton in the English market, and the market is supplied exclusively from Australia. A sample of bark from some **Acacia decurrens** grown on the Nilgiris was forwarded a few years ago to London for valuation. The reply stated that the sample of bark was in good condition and rich in tannin, but as buyers were in the habit of procuring their bark from a certain country, in regular quantities, there would be a prejudice in receiving it from a new source such as the East Indies, and there is nothing to guarantee their receiving a regular supply of the same quality. Tanners do not like changing the materials they employ, and English and Continental firms after obtaining wattle barks from the Australian Colonies for nearly a century are apt to look with suspicion upon other wattle barks. The following results were obtained in analysing the barks of the Nilgiri-grown acacias, in each case there was a small proportion of soluble non-tannins :—

Value of
Indian-grown
acacias.

A. pycnantha	.	.	.	.	33·8 per cent. tannin.
A. decurrens	.	.	.	.	33·4 „ „
A. melanoxylon	.	.	.	.	28·6 „ „
A. dealbata	.	.	.	.	17·8 „ „

The samples of **pycnantha** and **decurrens** were from a private estate near Dodabetta. The **melanoxylon** was from a good-sized tree after it had been cut up in logs for firewood, and represents the strength of the bark found on the majority of the fuel used in Ootacamund. The **dealbata** was a fresh sample from some young bushes of the very common yellow-flowering species. All these have an astringent principle of the same chemical characteristics, which is the same as that found in the trees grown in their own native country. Extracts or “tannage” have been made from these barks, preparations which hold the virtues in a concentrated form, and much better than the crude bark for exporting. There is a good market in Europe for well-prepared wattle bark extract, and the demand has been on the increase during the last few years.

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ACACIA
DECURRENS.

Distribution
of tannin.

ACACIA
CATECHU.

Determina-
tions of
catechin.

In order to test the value of the bark taken from different parts of the tree, the following estimations were made with **A. decurrens**. The branch bark yielded 14·7, the upper stem bark 25·4, and lower stem bark 33·4, per cent. of tannin.

Acacia Catechu, Willd. (*Dict. Econ. Prod.*, A. 137).

The wood of this tree yields the well-known cutch which is *par excellence* the tannin extract of India. Black catechu or cutch contains from 45 to 55 per cent. of mimotannic acid, a catechol tannin, associated with a crystalline principle named catechin. It is similar in properties to the pale catechu of commerce obtained from **Uncaria Gambier** (see page 45).

The colouring or dyeing constituent of cutch and gambier was shown by A. G. Perkin in 1897 to reside in quercetin.

Dr. Warth (*Indian Forester*, October and December, 1890) has reported on the yield of extract and catechin from five different qualities of the wood of **Accacia Catechu** from Oudh and Burma.

The professional makers of *kattah* from khair wood work up the stems found to have white spots in the heart wood. The reason is that the spotted wood yields more extract and more catechin than that without spots. This point was therefore investigated by collecting authentic specimens and subjecting them to analysis in a chemical laboratory. The catechin is decomposed during evaporation, and on re-crystallisation a loss of 32 per cent. was found.

The samples were thus described :—

1. Oudh No. 1. Reported unfit for making *kattah*, 1 in 1,000 of pores.
2. Oudh No. 2. Reported good for *kattah*, 1 in 6 of pores.
3. Burma A. No white spots, but *khersal* * present.
4. Burma B. Exhibiting white spots 1 in 20.
5. Burma C. White spots 1 in 3.

					Maximum per cent. extract.	Mean per cent. catechin.	Catechin per cent. in wood.
1.	.	.	.	.	14	36	5
2.	.	.	.	.	24	40	9
3.	.	.	.	.	17	14	2
4.	.	.	.	.	16	31	5
5.	.	.	.	.	20	28	6

* *Khersal* is a natural deposit of catechin found in cavities of the wood of khair and poon spar (*Calophyllum tomentosum*, Wight).

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ACACIA CATECHU.	The bark of the tree is rich in tannin and yields a satisfactory extract of a light colour ; crystalline catechu, however, appears to be absent from the preparation.
ACACIA CONCINNA.	Acacia concinna , <i>DC. (Dict. Econ. Prod., A. 208 (a)).</i> The bark is said to be used for tanning and dyeing in South India.
ACACIA FARNESIANA.	Acacia Farnesiana , <i>Willd. (Dict. Econ. Prod., A. 222).</i> This bark has been reported to be used in Dacca, mixed with salts of iron, to make an inky dye. A sample of the bark from South India yielded only 2·8 per cent. of tannin when extracted with hot water.
ACACIA INTSIA.	Acacia Intsia , <i>Willd. (Dict. Econ. Prod., A. 235).</i> The bark or the leaves of the fresh plant are said to be used as an auxiliary or astringent in dyeing with morinda or lac.
ACACIA LEUCOPHLOEA.	Acacia leucophloea , <i>Willd. (Dict. Econ. Prod., A. 251).</i> A specimen of bark sent as a tanning material from the Province of Mysore was found to be equal to the best babul bark ; the tannin content being 20·8 per cent. Another specimen examined at Dehra Dun yielded 9·33 per cent. with much soluble non-tanning bodies. The bark and leaves are used in Burma as dyeing agents (<i>Dr. Romanis</i>).
ACACIA PINNATA.	Acacia pinnata , <i>Willd. (Dict. Econ. Prod., A. 267).</i> A sample of bark from Bombay gave 8·8 per cent. of tannin, striking a black colour with iron salts.
ALBIZZIA LEBBEK.	Albizzia Lebbek , <i>Benth. (Dict. Econ. Prod., A. 703).</i> The bark is used for tannin leather. A sample from Dehra Dun afforded 11·33 per cent. of tannin and 4·3 per cent. of soluble non-tannins. The colour of the extract was intense.—(<i>Leather.</i>)
ALBIZZIA PROCERA.	Albizzia procera , <i>Benth. (Dict. Econ. Prod., A. 719).</i> The bark is sometimes used as a tan.
CÆSALPINIA CORIARIA.	Cæsalpinia coriaria , <i>Willd. (Dict. Econ. Prod., C. 24).</i> The American sumach or Divi divi was introduced into India in 1834 by Dr. William Hamilton. It has been cultivated in many districts of India with comparative success and the pods have been occasionally exported to London. The South American pods usually contained from 30 to 50 per cent. of tanning matter. The Indian-

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(D. Hooper.)

grown Divi divi has been regarded by the tanner as somewhat inferior to the American product, and this result was confirmed by Professor Hummel in 1886, and more recently by Professor Dunstan at the Imperial Institute. Professor Dunstan's report shows that pods from cultivated plants grown in Bengal give an average of about 30 per cent. of tanning matter. It is possible that samples collected from other districts and at different stages of growth might give better results (see *Agricultural Ledger*, No. 10 of 1899).

Cæsalpinia digyna, Rottl. (*Dict. Econ. Prod.*, C. 27).

CÆSALPINIA
DIGYNA.

This plant grows freely in Burma, Assam and Bengal, and the pods called *teri* pods are valuable astringents. Commercial specimens have been found to contain 33 per cent. of tannin, and leather made with the infusion was remarkably light in colour.

Specimens of *teri* pods were in 1898 obtained by the Reporter on Economic Products from Assam and Burma, and these were forwarded to the Imperial Institute for analysis and report. Professor Dunstan in 1899 gave the result of his examination which was most favourable. The pod cases, from which the oily seeds had been removed, showed a percentage of over 50 per cent. of tanning matter; in the Assam sample this amounted to nearly 60 per cent. These pods are therefore more valuable than the South American Divi divi, whilst the aqueous liquor does not appear to undergo the injurious fermentation which is so troublesome in the use of Divi divi. There would be no occasion to prepare an extract from these pods since they are so rich in tannin (see *Agricultural Ledger*, No. 9 of 1899).

The action of the Reporter on Economic Products in arousing an interest in these pods has caused a demand for them in commercial circles in Europe and America.

Cassia auriculata, Linn. (*Dict. Econ. Prod.*, C. 743).

CASSIA
AURICULATA.

The bark of this tree, known as *tarwar* in the Central Provinces and *tangedu* in Southern India, is one of the most valuable indigenous tans.

The following analyses of young and mature bark co Mysore indicate the composition of the tan as usually met with :—

	Young.	Mature.
Tannin	11'92	20'12
Phlobaphene	2'30	4'90
Extract	22'35	29'00
Ash	4'15	6'40
Moisture	7'26	7'80

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	A sample of the bark examined in Dehra Dun afforded 15·5 per cent. of tannin with a high accompaniment of soluble non-tannins. There was a very small amount of colour in the infusion (<i>Leather</i>).
CASSIA FISTULA.	Cassia Fistula, Linn. (<i>Dict. Econ. Prod.</i>, C. 758). The bark of the Indian Laburnum is used for tanning in Bengal, North-West Provinces and South India. The tannin content ranges from 9·5 to 12·9 per cent., but is habitually associated with an excessive quantity of soluble non-tanning substances.
CASSIA SIAMEA.	Cassia siamea, Lam. (<i>Dict. Econ. Prod.</i>, C. 785). Syn.—C. florida, Vahl. A sample of this bark sent as a tanning agent from Mysore afforded 4·1 per cent. of tannin.
CASSIA MARGINATA.	Cassia marginata, Roxb. (<i>Dict. Econ. Prod.</i>, C. 773). Syn.—C. Roxburghii, DC. A sample of this bark sent as a tanning agent from Mysore afforded 6·1 per cent. of tannin.
BAUHINIA spp.	Bauhinia purpurea, Linn. (<i>Dict. Econ. Prod.</i>, B. 312). B. variegata, Linn. (<i>Dict. Econ. Prod.</i>, B. 358). The barks of these trees are used for dyeing and tanning.
BUTEA FRONDOSA.	Butea frondosa, Roxb. (<i>Dict. Econ. Prod.</i>, B. 948). This tree affords an astringent gum or kino, and the bark is fairly tanniferous, but it does not appear to be used in the manufacture of leather.
CYLISTA SCARIOSA.	Cylista scariosa, Ait. (<i>Dict. Econ. Prod.</i>, C. 2553(a)). The root of this plant is an astringent medicine and contains about 10 per cent. of tannin.
DALBERGIA LATIFOLIA.	Dalbergia latifolia, Roxb. (<i>Dict. Econ. Prod.</i>, D. 40). A decoction of the bark sent as a tanning agent from Coorg was fairly astringent.
ENTADA SCANDENS.	Entada scandens, Benth. (<i>Dict. Econ. Prod.</i>, E. 220). The bark is employed for tanning skins. An allied species growing in Africa (E. africana, Guill. and Perr.) is also used for the same purpose.
MIMOSA PUDICA	Mimosa pudica, Linn. (<i>Dict. Econ. Prod.</i>, M. 561). The roots of the Sensitive plant contain about 10 per cent. of tannin.

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Prosopis spicigera, Linn. (*Dict. Econ. Prod.*, P. 1261).

The bark of this tree is used as a tan in Panjab.

PROSOPIS
SPICIGERA.

Pterocarpus Marsupium, Roxb. (*Dict. Econ. Prod.*, P. 1375).

The inspissated exudation or kino of this tree is a highly astringent substance largely used in medicine. The bark of the tree is used for tanning and is rich in kino-tannic acid. Extracts prepared from the bark have been recommended for manufacture on a large scale (*see Agricultural Ledger*, No. 11 of 1901).

PTERO-
CARPUS
MARSUPIUM.

Saraca indica, Linn. (*Dict. Econ. Prod.*, S. 862).

The bark of the Asoka tree is used in medicine and its properties appear to be purely astringent. A sample from Bombay contained 5.7 per cent. of tannin of such a nature as to give a greenish colour with iron salts.

SARACA
INDICA.

Tamarindus indica, Linn. (*Dict. Econ. Prod.*, T. 30).

The leaves of the Tamarind tree have been used for tanning.

Wagatea spicata, Dalz. (*Dict. Econ. Prod.*, W. 2).

The pods yield only 19.17 per cent. of tannin by Lowenthal's process (*Wardle*, 1879).

WAGATEA
SPICATA.

Xylia dolabriformis, Benth. (*Dict. Econ. Prod.*, X. 17).

A note in the "Indian Forester" for September 1896 drew attention to the refuse of *Pyinkado* timber as a source of tannin. Hundreds of tons of bark and sawdust are carted away as refuse from the saw mills of Burma, and it was suggested that tannin might profitably be extracted from the waste product. A specimen of extract examined by the Agricultural Chemist contained 89.5 per cent. of tannin.

XYLIA
DOLABRI-
FORMIS.

Specimens of the raw material from the Pyinmana Division, Burma, examined in the Economic Laboratory, Indian Museum, gave the following results :—

	Tannin.	Extract.	Moisture.	Ash.
Sawdust (10,442)	6.1	7.0	9.1	2.4
Chips (10,442-1)	5.4	6.0	8.0	4.1
Sawdust (11,408)	.8	1.0	20.8	2.2
Chips (11,408-1)	4.6	5.7	5.6	2.9

Analyses
of wood.

The proportions of extract in the wood are very low compared with other materials, *e.g.*, **Acacia Catechu**, but there is a large proportion of tannin in the extract. The dust (11,408) was damp and mouldy, and the analysis represents the detrimental influence

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XYLIA
DOLABRI-
FORMIS.

of these conditions in effecting a loss of tannin when articles of this nature are exposed for any length of time.

An experimental batch of extract was made at Pyinmana in 1897, and 97 lbs. was obtained from 2 tons of chips, and 58 lbs. from 2 tons of fresh sawdust. These preparations were not reduced to a solid condition, but were favourably reported upon by Professor Procter in 1898, as the following certificate will show:—

“The following are the results of the analysis of the sample of *Xylia dolabriformis* extract (marked Pyinkado), according to the method of the International Association of Leather Trade Chemists:—

Analysis of
extract.

Tanning matters absorbed by hide	.	.	.	32'0
Soluble non-tanning matters	.	.	.	4'9
Insoluble (at 60 deg. Fah.)	.	.	.	5'0
Water	.	.	.	58'1
				100'0

“In its low percentage of soluble non-tannins, as well as in colour, it resembles Quebracho. It might become a very useful tanning material.

“The colour of a solution containing 0'5 per cent. of tanning matter as determined by above analysis, measured by the tintometer in a cell 1 centimeter thick, is Red 4'0, Yellow 8'8, Black 0'7, and a sample of leather tanned in one per cent. solution * * * is reddish, but not more so than Quebracho or Mimosa” (see *Agricultural Ledger*, No. 11 of 1899).

ROSACEÆ.

AGRIMONIA
EUPATORIUM.

Agrimonia Eupatorium, Linn. (*Dict. Econ. Prod.*, A. 650).

Agrimony is used in Europe as a popular astringent. The herb contains about 5 per cent. of tannic acid. It grows in the temperate Himalayas and is occasionally collected.

POTENTILLA
spp.

Potentilla Leschenaultiana, Ser.

„ *nepalensis*, Hook.

„ *supina*, Linn.

These plants contain red colouring and astringent properties and are used in India as substitutes for the Pentaphyllon or Cinquefoil of the Greeks and early writers, which is generally identified with L. 167-76.

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Potentilla Tomentilla, *Sibth.* A sample of the root of the first-named plant from the Nilgiris contained 7·4 per cent. of tannic acid, giving a blue-black colour with salts of iron.

SAXIFRAGACEÆ.

Saxifraga ligulata, *Wall.* (*Dict. Econ. Prod.*, S. 925).

SAXIFRAGA
LIGULATA.

The astringent root of this plant is a well-known medicine described in Sanskrit works. A sample of the dried root from Bombay yielded 14·2 per cent. of tannic acid, similar in its properties to the gallotannic acid of oak-galls.

RHIZOPHORACEÆ.

(*The Mangrove Family.*)

Bruguiera gymnorhiza, *Lamk.* (*Dict. Econ. Prod.*, B. 899).

BRUGUIERA
GYMNOR-
RHIZA.

This mangrove is known as *Kankra* in the Sundarbans and is fairly abundant. It occurs also in French Cochin China where an extract is made of the bark and this is sent into the market as a substitute for catechu under the name of *Cay Day*.

Analyses made of samples of the bark collected in Bengal indicate their value as tannin yielders.

	Water.	Ash.	Tannin.	Tannin in dry.	
6721	. 14·14		...	12·77	(Dunstan)
10291	. 9·60	7·3	15·90	17·50	(Hooper)
	...	...	14·81	...	(Leather)

Dr. Busse obtained 44·71 to 53·12 per cent. of tanning extract from samples of this bark from East Africa. Mr. Staiger has reported the yield of 18·2 to 19·5 per cent. of tannin in the bark of *B. Rheedii*, *Blume.*, from Australia.

Analyses of the extracts made in India show the following composition:—

Water.	Ash.	Insol.	Sol. non. tans.	Tannin.	Tannin in dry.	
19·9	17·4	...	5·7	57	71·1	(Hooper)
17·87	...	7·57	18·23	56·33	68·7	} (Leather)
36·60	...	...	9·98	53·42	64·2	

The wood affords tannin as well as the bark, but its extract is much poorer. Bark extracts prepared at Dehra Dun in 1898 yielded 33, 46 and 51 per cent. of tannin by the Lowenthal's process, while

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BRUGUIERA
GYMNOR-
RHIZA.

two samples of extract from the wood gave only 13 and 16 per cent. of tannin.

CARALLIA
INTEGER-
RIMA.

Carallia integerrima, DC. (*Dict. Econ. Prod.*, C. 474.)

A specimen of this bark received in 1897 from Pegu afforded only 1·5 per cent. of tannin. The bark was about half an inch thick, and the ash content amounted to 15·2 per cent.

CERIOPS
CANDOLLE-
ANA.

Ceriops Candolleana, Arnott (*Dict. Econ. Prod.*, C. 965).

This bark is readily procurable from the Sunderbans, Bengal, where the trees are plentiful. There is a steady demand for *Goran* bark in the Calcutta market and about 10,000 to 12,000 maunds are sold annually for the purpose of tanning leather. The present price (1897) is 10 annas per maund of dry bark.

The tree also inhabits the banks of the tidal estuaries of Burma. In South Tenasserim the bark is used for dyeing fishing nets, and is called *kamyine* or *kalyaing* bark. Samples of bark and extract have been received from Tavoy and Bassein. *Tengah* bark in Singapore and *Bakan* bark from Borneo are referred to this tree and are made into extracts (*Kew Bulletin*, 1897).

The bark contains a considerable amount of tannin and gives a deep red decoction with water.

The following samples have been examined :—

	Water.	Ash.	Tannin.	Tannin on dry bark.	
1. Singapore .	13·34	10·60	20·00	23·07	} (<i>Trimble</i> , 1897).
2. Bengal .	13·70	5·83	27·24	31·56	
3. Bengal (10282)	13·30	10·60	26·20	30·20	} (<i>Hooper</i> , 1898).
4. „ (10283)	15·40	13·70	15·50	18·30	
5. „	...	...	18·78		(<i>Leather</i> , 1899).
6. „ (6719)	14·47	...	...	17·77	} (<i>Dunstan</i> , 1900).
7. „ (6358)	12·32	...	...	21·54	
8. „ (6621)	17·18	...	...	13·23	

Dr. W. Busse in a report on mangrove barks of East Africa avers that the inner dried bark of this tree contains, besides a red colouring matter, an average of 42·27 per cent. of tannin calculated upon the air-dried bark. These figures probably represent total extract and not the pure tannic acid.

Extracts.

Extracts.—The extracts prepared from the bark of this mangrove are highly astringent, and samples manufactured in the East have been for some years in the London market. In Singapore, Borneo

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(D. Hooper.)

and Ceylon, factories have been erected for the purpose of preparing cutch substitutes, and experiments have been conducted under the auspices of the Indian Forest Department for producing a suitable extract in the Sunderbans division, Bengal.

A series of analyses of these extracts is appended to illustrate their comparative richness in tanning properties :—

Reg. No.	Water.	Ash.	Insol.	Non-tan.	Tan.	Tan. on dry.
7138	21'96	...	...	...	...	73'04
7156	26'02	...	...	...	...	71'22
10281	14'20	14'3	9'7	7'9	53'9	61'60
...	29'87	...	...	6'99	60'98	86'95
...	19'37	...	...	10'80	69'83	86'60

(Dunstan.)

(Hooper.)

(Leather.)

In addition to these, further extracts were prepared at Dehra Dun from bark from the Sunderbans which gave percentages ranging from 65 to 90. These were all evaporated in an ordinary still and the results should encourage commercial trial. The ratio between the tannin and non-tannin soluble matter was 1 : '11 to 1 : '19.

Colour measurements of the samples sent to the Imperial Institute were made by Dr. Gordon Parker by the following method. A solution of the tanning material containing one-half per cent. of tanning matter is taken and the colour of the solution is observed in a tintometer as to the amount of red, yellow and black colouring matter in the half per cent. solution in a centimetre cell :—

Reg. No.		Yellow.	Red.	Black.
7138	Extract	60'6	64'2	6'4
7156	"	66'2	68'6	7'2

Professor Hummel reporting on the extract of **Ceriops Candolleana** from the Imperial Institute says :—

“ Calico boiled with an aqueous decoction of the extract containing copper sulphate acquires a pale reddish-brown colour ; when saddened with bichromate of potash the colour loses its redness, and is changed to a pale brown of a more neutral tint, but there is little or no increase in the depth of colour. Repetition of the dyeing and saddening processes gives a deeper brown, but is still very pale as compared with the colour given by a good quality of cutch.

“ The tinctorial power of the sample is so weak that it can have but little or no commercial value.”

The above extracts had been made from the bark of the mangrove tree, which is the portion of the tree most suitable for the purpose.

CERIOPS
CANDOLLE-
ANA.

Colour
measure-
ments.

Dyeing
properties.

Wood
extract.

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**CERIOPS
CANDOLLE-
ANA.**

The wood has been used experimentally, and fairly rich extracts have been manufactured from it, but the wood cannot be recommended for several reasons. The wood is more difficult to reduce to a powder than the bark. The total solid matter obtained from it is so much less than from the poorest samples of bark. The extract from the wood is more gummy and has not the brittle character of the other samples and is not so rich in astringent matter. The wood from the Sunderbans Forests has always such a ready sale for firewood in Calcutta that there is no immediate occasion to divert the industry.

**CERIOPS
ROXBURGHII-
ANA.**

Ceriops Roxburghiana, Arnott (*Dict. Econ. Prod.*, C. 973).

This mangrove is very similar to the species previously described. It is called *Baro goran* in the Sunderbans in distinction to the *Chota*, or smaller, *goran*, the vernacular name of the previous species.

The bark is usually in the form of reddish-brown quills or shavings, and its decoction gives a deep reddish colour and astringent reaction.

The following analyses of authentic barks collected in the Sunderbans Division of Bengal are fairly representative of their quality :—

Reg. No.	Water.	Ash.	Tannin.	Tannin on dry bark.
6059	12.14	...	...	23.54 (<i>Dunstan.</i>)
10285	9.2	18.60	19.20	21.10 (<i>Hooper.</i>)

A sample of extract prepared from the second specimen in Khulna had the following composition:—

Water.	Ash.	Insol.	Non-tan sol.	Tannin.	Tannin on dry bark.
13.9	15.8	9.8	7.0	53.5	62.1

A series of extracts made at Dehra Dun from bark of the above origin showed from analyses results as good as those from **Ceriops Candolleana**. The close botanical alliance of the trees and the similarity of the barks and extracts support the opinion expressed by Mr. J. S. Gamble, the Director, Imperial Forest School, that "in practice bark of both could probably be used indiscriminately."

**KANDELIA
RHEEDII.**

Kandelia Rheedii, W. and A. (*Dict. Econ. Prod.*, K. 22).

This mangrove is known as *Goria* in the Sunderbans, and *Kandel* on the Malabar coast. The bark is used for dyeing and tanning purposes.

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The following analyses indicate the quality of the bark as a tanning agent:—

Reg. No.	Water.	Ash.	Tannin.	Tannin on dry bark.
6720	14'29	...	...	11'99 (Dunstan.)
10288	9'90	9'8	12'20	13'40 (Hooper.)
...	...	...	14'54	... (Leather.)

A further specimen from the Sunderbans afforded 20'4 per cent. of tannin, and a sample from the Malabar coast, very thick, reddish and dense, gave no less than 27'4 per cent. of tannin.

The extracts, on the whole, are not such satisfactory preparations as those from the Ceriops barks.

Water.	Ash.	Tannin.	Tannin on dry.
23'06	...	...	34'21 (Dunstan.)
19'50	18'6	44'5	55'20 (Hooper.)
17'80	...	41'39	50'35 } (Leather.)
18'18	...	40'60	49'63 }

These extracts yield on the average half their weight of tannin calculated on the dry substance.

A sample of extract made from the wood of this mangrove was only slightly astringent and largely insoluble; most of the tannin having become oxidised during the process of evaporation to dryness.

Professor Hummel reports as follows on the dyeing properties of this extract: "When submitted to the test of dyeing calico this extract gives very poor results. Its colouring power is much inferior to that of the extracts of *C. Candolleana*, and it must be regarded as having no commercial value."

Rhizophora mucronata, Lamk. (Dict. Econ. Prod., R. 243).

This mangrove is known as *Bhara* in the Sunderbans Division of Bengal. It is also well known in Burma as *Pyu-bin*, and the bark is an article of export from Mergui to Rangoon. Considerable quantities of bark are exported from the grove swamps that line the Perak coast. The tree is called *Bakan* by the Malayas.

Analyses of the barks show a rather variable composition—

Reg. No.	Water.	Ash.	Tannin.	Tannin on dry.
6718	14'22	...	...	27'29 } (Dunstan.)
8615	13'17	...	...	4'13 }
10294	8'70	11'7	5'0	5'8 } (Hooper.)
10759	10'90	9'2	26'90	29'50 }

Other recorded tannin estimations of this bark are 19'47 (Leather, 1898), 25'10 air-dried, 29'22 steam-dried (Hunt and Mackay, Kew Bulletin, 1892), 28'85 air-dried (Staiger).

KANDELIA
RHEEDII.

Barks.

Extracts.

Dyeing
properties.

RHIZOPHORA
MUCRONATA.

Barks.

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RHIZOPHORA
MUCRONATA.

Dr. W. Busse found in the dried inner bark collected in East Africa 47·99 per cent. of extract consisting of tannin and brown colouring matter.

The astringent principle like that of other mangrove barks resides in a catechol tannin.

Extracts.

Extracts of the barks have given the following results on examination :—

Reg. No.	Water.	Ash.	Tannin.	Tannin on dry.
8650	13·41	...	...	75·94 (<i>Dunstan.</i>)
10293	11·00	14·5	29·8	33·50 (<i>Hooper.</i>)

Bark extracts prepared in 1898 were not very satisfactory ; it was found that phlobaphenes were formed during evaporation and much was lost. An extract made by the Divisional Forest Officer, South Tenasserim, in 1899, afforded 55·2 per cent. of tannin in the dry substance, and Messrs. Hunt and Mackay estimated 69·4 per cent. in the dried extract prepared in England.

The extract of the wood of this tree, like that of other mangroves, does not afford a satisfactory preparation.

Dyeing
properties.

The colour of one-half per cent. solution observed in a centimetre cell showed 30 yellow, 30 red and 4·2 of black. This extract is better than other mangrove extracts for purposes of the cotton dyer, but Professor Hummel considers it far from being equal to the best cutch sold for that purpose.

RHIZOPHORA
MANGLE.

Rhizophora Mangle, Linn.

A sample of bark received from Trinidad and analysed by Messrs. Hunt and Mackay of Leeds, March 1890, gave the following results :—

Total extract	.	.	.	.	33·04
Tannin, by hide powder	.	.	.	.	25·10
Other matters	.	.	.	.	7·94
Insoluble	.	.	.	.	52·85
Moisture	.	.	.	.	14·11

On boiling with acid the tannin was almost entirely converted into an insoluble "red" (phlobaphene). The solution yielded only a trace of gallic acid.

An infusion of the bark gave the following reactions :—With ferric chloride, dirty brown colour ; on adding N H₄ HO, dark chocolate brown precipitate. Tartar emetic, no precipitate. Lead nitrate, light coloured precipitate. With lime water, reddish-brown

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(D. Hooper.)

precipitate. Strong sulphuric acid, crimson colour. Bromine water, yellow precipitate.

RHIZOPHORA
MUCRONATA.

The tannin is a catechol tannin and resembles mimosa bark to some extent, but is not identical with it.

The extract or concentrated juice of the mangrove bark had the following composition :—

Total extract	.	.	.	.	82.00	
Tannin, by hide powder	.	.	.	.	...	58.30
Other matters	.	.	.	.	...	23.70
Insoluble	.	.	.	.	1.95	
Moisture	.	.	.	.	16.05	

(Kew Bulletin, 1892.)

COMBRETACEÆ.

Anogeissus latifolia, Wall. (*Dict. Econ. Prod.*, A. 1149).

ANOGEISSUS
LATIFOLIA.

The leaves and bark of this tree are astringent. A specimen of the bark from Madras yielded as much as 32.5 per cent. of tannin giving an inky colour with iron salts. A small quantity of extract prepared from the bark in Singhbhum division, Bengal, in 1899, gave an estimation of 43.8 per cent. of tannin. The extract, however, was badly prepared and contained insoluble substances.

The leaves are used in Bombay and North-Western Provinces for tanning, and Dr. Lyon found them to contain as much tannin as the Sumach. Professor Hummel examined a sample of these leaves obtained from Ajmere and found 15.5 per cent. of tannin. The decoction was pale yellow coloured and slightly turbid. The sale of the dried and powdered leaves has been suggested. Experimental extracts of the leaves have not been very satisfactory preparations on account of the insoluble matter and absence of brittleness in the finished product.

Anogeissus acuminata, Wall.

ANOGEISSUS
ACUMINATA.

The leaves are said by Gamble to be used for tanning.

A sample of extract (14531) made from the bark in Thyetmyo, Pegu, had the following composition :—Water, 33.6; tannin, 42.9; soluble non-tannins, 13; insoluble, 6.95; ash, 3.55; tannin in the dry extract, 64.6 per cent. This is a fairly satisfactory result.

Calycopteris floribunda, Lamk. (*Dict. Econ. Prod.*, C. 122).

CALYCOP-
TERIS
FLORIBUNDA.

The leaves have been found to contain 6.8 per cent. of gallotannic acid.

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**TERMINALIA
ARJUNA.****Bark.**

Terminalia Arjuna, *Bedd. (Dict. Econ. Prod., T. 284).*

The bark of this tree is astringent like others of this family and is occasionally used for dyeing and tanning. A specimen of the bark from South India afforded 16 per cent. of tannin giving a blue-black colour with ferric salts. The amount of tannin in a sample examined by Dr. Leather at Dehra Dun was not high (8.6 per cent.), but the small proportion of non-tannins was a favourable feature. Wardle, in 1887, separated 15 per cent. from a specimen of bark from Midnapore, Bengal.

The bark leaves a large quantity of white ash on ignition, in one instance as much as 34 per cent. This fact is made use of by natives who utilise the ashes of the burnt bark of several *Terminalias* as a source of lime for eating with *pan*.

Fruits.

The fruits of this tree are not recognised as myrobalans. A single sample analysed by Dr. Paul, in 1883, gave only 1.33 per cent. of gallotannic acid, a result which if representative of the half-ripe nut would condemn it as a tanning material. Dr. Leather obtained 9.6 per cent. from a sample sent to the Forest School, Dehra Dun, in 1900.

**TERMINALIA
BELERICA.**

T. belerica, *Roxb. (Dict. Econ. Prod., T. 295).*

The fruit is a commercial article under the name of Beleric Myrobalans, but it is inferior to the true Indian or Chebulic Myrobalans. Its composition is more nearly related to the fruits of **T. tomentosa**.

Dr. Paul found 5 and 6.7 per cent. of tannin in two samples supplied to him at a Conference held at the Indian and Colonial Exhibition, while Professor Hummel obtained 17.4 per cent. Dr. Leather found 8.6 per cent. with a large amount of extractive. This shows the variation between the fruits of the same tree either because of their growing in different districts or because of their stage of maturity. The fruit consists of two distinct portions, an outer and an inner; 100 parts contain 75.4 parts of outer and 24.6 parts of inner integument. The inner portion contains only 1.25 per cent. of tannic acid. The nuts are sold in England and employed as an adulterant of ground myrobalans.

**TERMINALIA
CATAPPA.**

Terminalia Catappa, *Linn. (Dict. Econ. Prod., T. 314).*

The bark and leaves of the Country Almond give a black dye with salts of iron on account of the tannin they contain. Wardle, in **L. 167-76.**

Indian Tanning Materials.

(D. Hooper.)

1887, separated 9 per cent. of tannin from a specimen of the bark from Madras.

Terminalia Chebula, Retz. (*Dict. Econ. Prod.*, T. 327).

TERMINALIA
CHEBULA.

The fruits of this tree, well known as Chebolic Myrobalans, are a valuable tannin agent. The tree is widely distributed in India, and the fruits are collected largely by the Forest Department and exported to Europe.

The dried fruits known as *hurra*s or *hurdas* are extremely rich in gallo-tannic acid and require no preparation except powdering or crushing in a mill. Some recent (1900) analyses by Dr. Leather of samples obtained from different provinces fairly indicate their composition:—

	Extract.	Tannin.
Madras	57.87	38.67
Bombay	59.47	40.80
North-Western Provinces	59.47	43.74
Central Provinces	...	31.00

The fruits should be collected before maturity, otherwise there is apt to be a variation in their strength. Dr. B. H. Paul, for instance, examined indiscriminately three samples submitted to him at the Indian and Colonial Exhibition in 1886, and he obtained 32.8, 26.8 and 6.1 per cent. of tannin. The oblong pointed solid fruits are much superior to the round and inflated ones. The astringent principle resides in the outer pulp of the fruit, the stone-like kernel containing hardly any.

The fruits are not liable to deterioration, so that it is more economical to export them in their natural condition. The extract made in open pans tends to absorb moisture and to ferment when exposed to the air. It would, therefore, not be satisfactory to prepare a tannin extract from myrobalans, unless made with skilled appliances.*

The bark of **T. Chebula** provides a valuable tan as the following analyses will show:—

	Tannin.	Extract.	Moisture.	Ash.
Bark from young tree	34.9	45.8	9.9	12.1
" " mature tree	33.0	35.7	10.8	11.3
" " old tree	27.5	31.2	9.5	19.1

The bark is thus a rival to the fruits in astringent properties. The percentage of tannic acid is not far short of that found in average samples of ground myrobalans.

Galls are found on the leaves and twigs of this tree and are used in the preparation of ink.

* A factory with vacuum apparatus has recently been established at Raniganj for preparing tanning extract from Myrobalans.

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TERMINALIA
MYRIO-
CARPA.

Terminalia myriocarpa, *Heurck and Muell.-Arg. (Dict. Econ. Prod., T. 354).*

Samples of bark and bark extract from this species were forwarded, as suitable tanning materials, by Mr. W. F. Lloyd from the Tista Division of Bengal in 1898. The analysis of the bark, made in the Economic Section of the Indian Museum, afforded the following results :—Moisture, 12·1 ; tannin, 22·4 ; extract, 35 ; ash, 8·9 per cent.

TERMINALIA
OLIVERI.

Terminalia Oliveri, *Brandis.*

This tree is the *than* of Burma, and *than-sha*, the extract made from the bark, has been said to be an injurious adulterant of cutch. An enquiry into the properties of the bark was instituted in 1897 by the Director of the Royal Gardens, Kew, at the instance of Professor Procter, of Leeds. The Reporter on Economic Products to the Government of India collected a store of information on the subject which was published in the *Agricultural Ledger*, No. 8 of 1900.

Professor Procter found in the bark of the tree as much as 31·1 per cent. of tannin, and in the leaves 14·4 per cent.

Professor Dunstan examined the extract (*than-sha*) at the Imperial Institute and separated 68·27 per cent. of tannin. It gave the reactions of cutch prepared from **Acacia Catechu**, and the colouring matter was low. It may, therefore, be regarded as a concentrated and pure tanning material worthy of more extended trial.

TERMINALIA
TOMEN-
TELLA.

Terminalia tomentella, *Kurz.*

The Conservator of Forests, Western Circle, Burma, sent in December 1895 a quantity of dried *panga* fruit, and requested the Director of the Imperial Forest School to ascertain the value of the fruits as a tanning material. The Agricultural Chemists to the Government of India reported that they contained 3·7 per cent. of tannin by Lowenthal's process. The fruits will, therefore, never be able to compete with true myrobalans.

Terminalia paniculata, *Roth. (Dict. Econ. Prod., T. 356).*

The bark of this tree is used on the Western Coast for dyeing and tanning. A decoction of the bark received from Coorg contained a large proportion of tannin.

Terminalia pyrifolia, *Kurz.*

An extract of the bark of this tree is used in Burma for the purpose of mixing with cutch.

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Indian Tanning Materials.

(D. Hooper.)

Terminalia tomentosa, Bedd. (*Dict. Econ. Prod.*, T. 363).

TERMINALIA
TOMENTOSA.

The nuts of this tree, which is very plentiful in Chutia Nagpur, were supplied by Rev. A. Campbell, but after submitting them to chemical analysis they were declared valueless. Dr. Paul detected 5.9 per cent., and Professor Hummel only 4 per cent. of tannin in these nuts; these figures represent about one-fifth the proportion of tanning principle usually found in chebulic myrobalans.

The *Sein* or *Asain* tree is very abundant in forests that are being cut up for railway extensions, and the bark is often wasted. The Inspector General of Forests in 1899 selected the bark as a subject for special investigation with a view to the use of its extract as a tanning agent. The bark is already used as a tan in Cawnpore and elsewhere, and it imparts a characteristic red colour to native leather.

The value of the bark in tannin has been variously given. Dr. Leather estimated 11.74 per cent. with 4.1 per cent. of soluble non-tannins. The colouring matter observed through a tintometer was high.

A selection of barks for making tannin extracts were examined at the Economic Laboratory, Indian Museum, with the following results :—

Barks.

			Tannin.	Extract.	Moisture.	Ash.
10976	North-West					
	Provinces	Old trees	11.8	20.5	12.6	25.0
10976-1	North-West					
	Provinces	Coppiced tree	12.3	26.0	19.4	22.0
10976-2	North-West					
	Provinces	Old branches	13.6	19.7	10.0	20.7
11094	Goalpara	Mature tree	8.6	15.5	11.8	12.5
11094-1	"	Old branches	5.7	7.5	12.0	24.4

The barks from the North-West are somewhat richer than those from Goalpara, but this must not be attributed to the district, as the Goalpara barks were mouldy, and had probably deteriorated. There is a considerable amount of ash in the bark, a feature which is peculiar to the Terminalias. The ratio between the tannins and soluble non-tannins is extremely variable, and shows the presence of a quantity of inert matter.

A large number (15) of extracts were prepared from *Sein* barks at Dehra Dun and the amount of tannin ranged from 32.1 to 68.8. These came from Saharanpur, Hoshangabad and Burma. The richer extracts were made from the bark taken from the old trees. The extracts were more or less dark coloured, and it was found that the darkest coloured extracts were weakest in tannin.

Extracts.

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Two samples of the extract were sent to Messrs. Schonbank & Sons, of Berlin, for analysis and opinion—

	1	2
Tanning agents	52'5	23'4
Non-tanning soluble agents	27'1	33'4
Insoluble	6'8	31'6
Water	13'6	11'6
	<u>100'0</u>	<u>100'0</u>

These were reported to be too dark in colour and to contain too large a proportion of non-tanning soluble substances. To find a market in Europe for such preparations it is absolutely necessary to decolourise the liquid solutions before condensation and to conduct the condensation in a vacuum.

MYRTACEÆ.

BARRING-
TONIA
ACUTAN-
GULA.

Barringtonia acutangula, Gaertn. (*Dict. Econ. Prod.*, B. 181).

The bark is used as a fish intoxicant, and also for tanning. (*Gamble*).

CAREYA
ARBOREA.

Careya arborea, Roxb. (*Dict. Econ. Prod.*, C. 565).

The bark is used for tanning in Burma. A liquid extract supplied by the Deputy Conservator of Forests, Coorg, was highly astringent.

The leaves of this tree afford about 19 per cent. of tannin.

Extracts of the bark and wood made as an experiment at Baraich, North-Western Provinces, contained about a quarter of their weight of available tanning matter, with a large proportion of insoluble substances and mineral matter or ash.

EUGENIA
CARYO-
PHYLLATA.

Eugenia caryophyllata, Thunb. (*Dict. Econ. Prod.*, C. 708).

Syn.—*Caryophyllus aromaticus*, Linn.

It is not usually known that the spice called cloves is very astringent. The tannin separated from cloves is gallotannic acid and the proportion ranges from 10 to 13 per cent. (*W. L. Peabody*, 1895).

EUGENIA
JAMBOLANA.

Eugenia Jambolana, Lam. (*Dict. Econ. Prod.*, E. 421).

The bark of the *Jam* is used for dyeing and tanning in Assam, Bengal and South India. It is sometimes combined with *goran* bark (*Ceriops Candolleana*). A sample examined at Dehra Dun afforded 19 per cent. of tannin accompanied by 7 per cent. of soluble non-tannins. The colour of the solution was high.

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(D. Hooper.)

The fruit also is highly astringent.

Bark from species of *Eugenia* have been collected on the Nilgiri Hills and examined for tannin with the following results :—

	Extract.	Tannin.
<i>Eugenia Arnottiana</i> , Wight . . .	25.0	16.1
" <i>Jambos</i> , Linn.	20.7	12.4
" <i>jambolana</i> , Lam.	16.6	12.0
" <i>montana</i> , Wight	20.1	11.9
" <i>caryophyllifolia</i> , Wight . . .	15.5	10.1

EUGENIA
spp.

Psidium Guajava, Linn. (*Dict. Econ. Prod.*, P. 1344).

PSIDIUM
GUAJAVA.

The leaves are occasionally used in tanning in Bengal and North-Western Provinces, either alone or mixed with mango or *mahwa* leaves.

The tree is called *malaka* in South Tenasserim, Burma, and the bark is employed by the fishermen for dyeing their nets. A specimen of the decoction used in the process was found to be rich in tannin.

An authentic specimen of the bark from South India contained 27.4 per cent. of tannic acid giving a blue-black colour with iron salts.

Rhodomyrtus tomentosa, Wight (*Dict. Econ. Prod.*, R. 282).

RHODOMYRTUS
TOMENTOSA.

The bark of the "wild gooseberry" tree of the Nilgiris yields about 19 per cent. of tannin.

LYTHRACEÆ.

Lagerstroemia Flos-reginæ, Retz. (*Dict. Econ. Prod.*, L. 45).

" *lanceolata*, Wall.

" *parviflora*, Roxb. (*Dict. Econ. Prod.*, L. 58).

LAGERSTROEMIA
spp.

The barks of these trees are somewhat astringent and are occasionally used as substitutes for the more useful tanning barks; they, however, contain an excess of non-tanning substances, and the colour of the infusions is deeper than that of ordinary bark infusions.

Punica Granatum, Linn. (*Dict. Econ. Prod.*, P. 1420).

PUNICA
GRANATUM.

Pomegranate rind is one of the most ancient tan-stuffs. It was used by the Romans for tanning leather as it is in Tunis and throughout the East at the present day. The peel of the fruit contains a tannin, the reactions of which agree with those of gallotannic acid of nut galls (*J. Culley*, 1894). A specimen from Oudh examined by Wardle in 1887 afforded 25.2 per cent. of tannin, and one from Shikapur 25.5 per cent.

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The bark yields about 22 per cent. of ellago-tannic acid as well as a little gallic acid.

The root affords a light coloured infusion yielding 7 per cent. of tannin accompanied by a high proportion of non-tannins (*Leather*).

SONNERATIA
spp.

Sonneratia acida, Linn. (*Dict. Econ. Prod.*, S. 2362).

S. apetala, Ham.

These trees are fairly plentiful in the Sunderbans, and the fruits and barks are astringent and might be serviceable as tanning agents. Dr. W. Busse obtained 16.5 per cent. of tannin from the bark of **S. caseolaris**, Linn., growing in East Africa, and there was an absence of colouring matter.

WOODFORDIA
FLORIBUNDA.

Woodfordia floribunda, Salisb. (*Dict. Econ. Prod.*, W. 108).

Professor Hummel obtained 20.6 per cent. of tannic acid in a sample of dried flowers from Calcutta. The decoction was deep reddish coloured and turbid. He remarks "I was somewhat surprised to find the flowers of **Woodfordia floribunda** contain such a large percentage of tannic acid; but it explains why the Hindus use these flowers in connection with alum as a mordant, and with other dye-stuffs, e.g., **Morinda**, as mentioned in the Exhibition Catalogue. It would be interesting to examine the leaves of the plant."

A specimen of the dried leaves in the Indian Museum, Calcutta, afforded as much as 10 per cent. of tanning matter giving a blue-black colour with salts of iron.

SAMYDACEÆ.

CASEARIA
TOMENTOSA.

Casearia tomentosa, Roxb. (*Dict. Econ. Prod.*, C. 726).

The bark of this tree afforded Dr. Leather 11.33 per cent. of extract of which half consisted of tannic acid; the colour of the infusion observed in a Lovibond's tintometer was very high.

RUBIACEÆ.

Many plants in this natural order contain in their barks a tannic acid characterised by colouring iron salts greenish.

ADINA
CORDIFOLIA.

Adina cordifolia, Hook. f. (*Dict. Econ. Prod.*, A. 515).

The bark is very astringent.

CINCHONA
spp.

Cinchona spp. (*Dict. Econ. Prod.*, C. 1133).

The cultivated Cinchona barks of the Darjeeling District and Nilgiri Hills contain a catechol-tannin named cinchona-tannic acid L. 167-76.

Indian Tanning Materials.

(D. Hooper.)

which affords an excellent tan. But the employment of the bark for the manufacture of the more valuable constituent quinine, or of the mixed alkaloids, called febrifuge, altogether precludes its use for tanning purposes.

Gardenia campanulata, Roxb (*Dict. Econ. Prod.*, G. 197 (a)).

The roots possess a slight astringency represented by 2.4 per cent. of tannin (*Leather*).

GARDENIA
CAMPANU-
LATA.

Hymenodictyon excelsum, Wall. (*Dict. Econ. Prod.*, H. 519).

The bark has been reported as being powerfully astringent.

HYMENO-
DICTYON
EXCELSUM.

Uncaria Gambier, Hunter.

UNCARIA
GAMBIER.

"Gambier is obtained from the leaves and twigs of the **Uncaria Gambier**, a plant which occurs wild and is cultivated in the Straits Settlements, Johore, Java and Sumatra. The manufacture is very primitive. A plantation is generally cropped after about 18 months, the cropping being repeated as much as four times a year. The leaves, etc., are boiled until a syrup is obtained, the extract poured off, cooled and stirred until it commences to solidify, it is then cut into cubes and air-dried, or dried in smoke. A plantation lasts about ten years and is abandoned in 15 years at the latest. It is pale brown or yellow, and has an even, earthy fracture; the quality varies much and adulteration is practised. It seems to have been used in India for dyeing at a very remote period, and was introduced into Europe at the beginning of this century; it is now extensively used in dyeing, and is a valuable medicine. It is rapidly coming into use for tanning purposes. Owing to the cheapness of its production it will probably in time take the place of hemlock bark (see page 4). The importation from the Straits Settlements and Japan into Great Britain is 20,000 tons per annum. The amount shipped through Singapore to the United States for the year 1891 was 113,730 piculs (1 picul = 133 $\frac{1}{3}$ lb) or about one-ninth of the total export. With improved management the production of gambier is certain to develop largely before long." (*U. S. Consular Rep. No. 149, February 1893, 201-202.*)

Gambier from the Straits Settlements intended for India is nearly all received in Bengal. The following figures give the import for the past five years:—

1895-96.	1896-97.	1897-98.	1898-99.	1899-1900.	
21,191	19,946	27,245	19,992	23,901	Cwts.
4,53,431	4,36,029	5,13,942	3,04,115	3,64,732	Rs.

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SAPOTACEÆ.

ACHRAS
SAPOTA.**Achras Sapota**, *Linn. (Dict. Econ. Prod., A. 378).*

The bark of the sapota plum tree was investigated in 1882 by Bernou, who separated 11·8 per cent. of sapotannic acid.

BASSIA
spp.**Bassia latifolia**, *Roxb. (Dict. Econ. Prod., B. 223).*

The bark and leaves of the Mahwa tree are sometimes used as a tan.

The leaves, however, according to Professor Hummel, contain only traces of a tanning principle.

Bassia longifolia, *Linn. (Dict. Econ. Prod., B. 272).*

A sample of this bark from Madras yielded 27·3 per cent. of extract, and 17 per cent. of tannin, greenish with iron salts.

MIMUSOPS
spp.**Mimusops Elengi**, *Linn. (Dict. Econ. Prod., M. 577).*

The bark is astringent and is used for tanning. Professor Hummel found 4 per cent. in a specimen submitted to him in 1887; the decoction was deep reddish coloured and slightly turbid. A sample more recently examined from Madras contained 6·7 per cent.

Mimusops hexandra, *Roxb. (Dict. Econ. Prod., M. 583).*

A sample of this bark sent as a tanning bark from Tanjore afforded 32·7 per cent. of extract and 10·3 per cent. of tannin, greenish with iron salts.

Mimusops littoralis, *Kurz. (Dict. Econ. Prod., M. 604).*

The bark according to Major Ford yields a red dye in the Andamans.

EBENACEÆ.

DIOSPYROS
EMBRYOP-
TERIS.**Diospyros E***Pers. (Dict. Econ. Prod., D. 585).*

The mucilaginous and astringent pulp of the fruit of the *Gab* tree is used to paint the interior of boats to render them waterproof. It acts as a kind of varnish, the tannin solution drying up to an insoluble film on exposure to air. An infusion is said to preserve fishing nets.

A sample of fruit from Calcutta afforded 15 per cent. of tannic acid, and of the bark from Madras 12·4 per cent. The colour of the decoction was pale reddish. The dried fruit is somewhat tough and consequently difficult if not impossible to grind. An extract has been recommended, but the heat employed in preparing the extract is liable to oxidise the tannin and render it insoluble in water.

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(D. Hooper.)

Diospyros burmanica, Kurz. (*Dict. Econ. Prod.*, D. 558).

DIOSPYROS
BURMANICA.

The bark of this tree is used for tanning purposes in Burma. The tannin is abundant and gives a blue-black colour with iron salts.

A sample of the extract prepared at Thayetmyo, Pegu, was of a softish consistence and had the following composition :—Water, 21·5 ; tannin, 32·1 ; soluble non-tannins, 29·2 ; insoluble, 10·95 ; ash, 6·25 per cent. Tannin in the dry extract, 40·9 per cent.

D. melanoxyton, Roxb. (*Dict. Econ. Prod.*, D. 618).

The bark of the Coromandel Ebony tree is also used as a tan.

STYRACEÆ.

Symplocos racemosa, Roxb. (*Dict. Econ. Prod.*, S. 3063).

SYMPLOCOS
RACEMOSA.

The ashes of the bark of this and other species of *Symplocos* are used by dyers as a mordant because of their alkaline properties. *Lodh* bark itself has been tested and found to contain no tanning matter.

OLEACEÆ.

Ligustrum Roxburghii, C.B. Clarke (*Dict. Econ. Prod.*, L. 350.)

LIGUSTRUM.
ROXBURGHII.

The bark is astringent, and is used in South India to regulate the fermentation of toddy.

APOCYNACEÆ.

Apocynum venetum, Linn. (*Dict. Econ. Prod.*, A. 1239).

APOCYNUM
VENETUM.

The bark of the rootstock is employed for tanning or rather pre-parting skins to hold water. The skins become red coloured and waterproof after treatment. The bark is known as *Gas gosh* = cow's ear (*Aitchison*).

Carissa Carandas, Linn. (*Dict. Econ. Prod.*, C. 597).

CARISSA
CARANDAS.

The fruit called *karincha* is used as an auxiliary in dyeing and tanning.

ASCLEPIADACEÆ.

Periploca aphylla, Decne. (*Dict. Econ. Prod.*, P. 419).

PERIPOLOCA
APHYLLA.

A sample of this bark has been found to contain 8 per cent. of tannin, but a larger amount than this of non-tannin is present which renders it useless for the manufacture of extract (*Leather*).

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VERBENACEÆ.

AVICENNIA
OFFICINALIS.**Avicennia officinalis**, Linn. (*Dict. Econ. Prod.*, A. 1656.)

The white Mangrove bark is astringent and used in tanneries. It yields, in addition to the tannin, a colouring material and a large quantity of ash.

POLYGONACEÆ.

POLYGONUM
spp.**Polygonum Bistorta**, Linn.

The Bistort root has been long known as a powerful styptic. A specimen examined by Mr. H. K. Bowman in 1869 yielded 21 per cent. of tannic acid.

P. Hydropiper, Linn. (*Dict. Econ. Prod.*, P. 1096).

Trimble and Schuchardt (1885) estimated the amount of tannin in a sample of the root at 3·4 per cent.

P. viviparum, Linn. (*Dict. Econ. Prod.*, P. 1112).

The root of this plant is very astringent.

RUMEX
NEPALENSIS.**Rumex nepalensis**, Wall. (*Dict. Econ. Prod.*, P. 648).

This Indian dock is a harmful weed in cultivated estates. The root contains some interesting colouring principles allied to chrysophanic acid which have been investigated by Dr. O. Hesse, of Stuttgart (*see Agricultural Ledger*, No. 29 of 1896).

Analyses of the roots of the plant have been made by Professor Trimble, of Philadelphia, and the Agricultural Chemist to the Government of India. The results were communicated to the Conservator of Forests for Bengal, and were published in the Annual Report for 1895-1896. The amount of tannin in the roots ranged from 5·5 to 6·3 per cent., and the quality was similar to that found in oak bark. The proportion of astringent matter, however, is too low to render the root a valuable tanning agent.

RUMEX
HYMENOSEPALUS.**Rumex hymenosepalus**, Torr.

Canaigre root has been used by the Indians of North America for over two centuries. In 1878 it was reported upon by the Agricultural Department at Washington, and since that time it has been repeatedly analysed and noticed in American Journals. It yields at different seasons of the year from 16·7 to 28·2 per cent. of tannin and the

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(D. Hooper.)

average quality has been found to yield 23 per cent. The plant has been cultivated in the Horticultural Gardens in the North-Western Provinces during the past three or four years.

A specimen of the root was analysed in the Indian Museum in 1900 and was found to contain 9.75 per cent. of water, 5.4 per cent. of ash, and yielded 12.5 per cent. of tannic acid. The root also contained starch and a large quantity of mucilaginous matter soluble in dilute alkali. The tannin agrees in composition with that from mangrove and rhatany.

Canaigre tanned leather is soft, bright and orange coloured, and is recommended for uppers of boots, saddlery and fancy leather. There is a good demand for the root in America, which, in the opinion of some experts, may soon replace gambier.

Chemically the acclimatised root is inferior to the original canaigre, but it would be interesting to know from a tanner's point of view whether it is superior in any way to ordinary tanning materials, such as the bark of *Acacia arabica* and country myrobalans.

There are so many good tanning substances in India that it would appear superfluous to cultivate foreign products, however well they may have been recommended.

MYRISTICACEÆ.

Myristica spp. (*Dict. Econ. Prod.*, M. 902.)

The wild nutmeg trees of India are more or less tanniferous, and yield a kino-like exudation when the bark is sliced or punctured. This juice has been noticed in *M. longifolia*, Wall., by Kurz in Burma, and in *M. laurifolia*, Hook. f. and Thorns. by Mr. T. F. Bourdillon in Travancore.

The bark of *M. Kingii*, Hook. f., (*Rampowa*) yields a red juice in great abundance at the end of the rains, and the natural juice of *M. gibbosa*, Hook. f. and Thorns. is employed as a kind of varnish in Assam. The fresh juice is painted over timber and renders it impervious to moisture. (*See Agricultural Ledger*, No. 5 of 1900.)

LAURACEÆ.

Cinnamomum spp.

The barks of the wild Cinnamon trees are astringent and mucilaginous, and although unsuitable for tanning purposes, they have been

RUMEX
HYMENO-
SEPALUS.

Value of
cultivated
root.

MYRISTICA
spp.

CINNAMO-
MUM
spp.

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utilised for regulating the fermentation of toddy like other barks of a decidedly astringent nature.

The leaves have been used in calico printing in conjunction with myrobalans.

LITSEA
spp.

Litsea Wightiana, Wall. (*Dict. Econ. Prod.*, L. 114a.).

The bark of this Nilgiri species has afforded 5·8 per cent. of tannin giving a greenish reaction with ferric salts.

L. zeylanica, C. and T. Nees, (*Dict. Econ. Prod.*, L. 494).

The bark of this tree has been found to contain 7·3 per cent. of tannin, similar to the above, and associated with mucilaginous matter.

LORANTHACEÆ.

The parasitic plants belonging to this natural order are more or less tanniferous. The peculiar constituents of the host plants are not absorbed by the parasite, as was formerly supposed. M. A. Chatin of the Paris Academy of Sciences, in 1891, showed that the tannin of the mistletoe was not identical with that of the oak on which it grows, and that the **Loranthus** of the nux-vomica tree contains no strychnine or brucine.

LORANTHUS
LONGI-
FLORUS.

Loranthus longiflorus, Desr. (*Dict. Econ. Prod.*, L. 172).

The bark of this parasite from the Oudh Forest afforded Wardle 10 per cent. of tannin producing a bluish-black colour with iron salts.

SANTALACEÆ.

OSYRIS
ARBOREA.

Osyris arborea, Wall. (*Dict. Econ. Prod.*, O. 526).

This shrub is common on the Himalaya and the Nilgiri Hills. It was at one time said to be the source of the Maun or Bischar Tea mentioned in Moorcroft's Travels in Tibet. The leaves have not an unpleasant odour when dry, but they are said to be very nauseous if taken in a fresh state. Some of these leaves gathered on the Nilgiris were examined in 1895, and the chief constituent was found to be tannic acid which amounted to over 20 per cent. The leaves would, therefore, be worthy of further investigation as a substitute for Sumach.

Osyris
compressa,
of Africa.

Villon has separated osyris-tannic acid from the leaves of **Osyris compressa**. A.D.C., (*Colpoon compressum*, Berg.) a tanning L. 167-76.

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(D. Hooper.)

material of South Africa, and a further examination was made by Mr. A. G. Perkin in 1897. The leaves contain 23 per cent. of a catechol tannin giving a green black with ferric salts. These are as strong as the average Sicilian Sumach (**Rhus Coriaria**) and although its tannin is differently constituted, it produces a very similar leather. The tannin closely resembles quinotannic and quinovatannic acid which are decomposed by acid into a sugar and an anhydride, and yield protocatechuic acid on fusion with an alkali. The colouring matter is quercetin.

Santalum album, Linn. (*Dict. Econ. Prod.*, S. 790).

SANTALUM
ALBUM.

The bark of the Sandal wood tree contains a small quantity of tannin, but the fragrant wood yields none.

EUPHORBIACEÆ.

Aleurites moluccana, Willd. (*Dict. Econ. Prod.*, A. 739).

ALEURITES
MOLUCCANA

The bark of this tree is used in Japan, and contains 22 per cent. of tannin, but on account of the red colouring matter associated with it, neither the bark nor extract would find a ready market in Europe. (*Journ. Soc. Chem. Ind.*, Mch. 30, 1901, p. 265.)

Aporosa villosa, Baill. (*Dict. Econ. Prod.*, A. 1249).

APOROSA.
VALLOSA.

A sample of the bark of this tree examined at Dehra Dun afforded 8 per cent. of extract, of which 4 per cent. consisted of tannin. The colouring matter was low.

Baccaurea sapida, Muell.-Arg. (*Dict. Econ. Prod.*, B. 6).

BACCAUREA
SAPIDA.

The leaves are used as dye in Bengal and Assam, but yield no tannin. (*Hummel.*)

Bridelia montana, Willd. (*Dict. Econ. Prod.*, B. 864).

BRIDELIA
spp.

Dr. Dymock has suggested the use of the leaves for tanning purposes. A sample of the bark tested at Dehra Dun yielded only 5.7 per cent. of tannin. The colour of the infusion was high.

Bridelia retusa, Spreng. (*Dict. Econ. Prod.*, B. 869).

The bark is considered very astringent in Coorg and Travancore where it is used for tanning purposes.

A sample of the bark collected on the Gudalur ghaut, Nilgiris, yielded a blood-red juice when cut with a knife, and was found to contain, in a dry state, nearly 40 per cent. of tannin giving a blue-black colour with iron salts.

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FLUEGGIA
SPECIES,
SPP.**Flueggia Leucopyrus**, Willd. (*Dict. Econ. Prod.*, F. 651-6.)

Bark affords 10 per cent. of tannin giving a violet black colour with ferric salts. It is used as a fish poison in Madras.

Flueggia microcarpa, Blume, (*Dict. Econ. Prod.* F. 651-6).

A sample of the air-dried bark from Madras contained 8.9 per cent. of tannin.

CLEISTAN-
THUS
COLLINUS.**Cleistanthus collinus**, Benth. (*Dict. Econ. Prod.*, L. 220).

The bark of this tree called *Kodarsi* in Hyderabad, Deccan, has been stated to be poisonous to fish and to be avoided by white ants. The inner barks placed on the sores of sheep and goats is efficacious in healing them and destroying maggots (*Biscoe*).

The air-dried bark collected in the Deccan contained 33.3 per cent. of tannin, a quantity above that found in ordinary tanning barks. There was no alkaloid or glucoside present (*Indian Forester*, Vol. XXIV (1898) p. 161).

MACARANGA
ROXBURGHII.**Macaranga Roxburghii**, Wight (*Dict. Econ. Prod.*, M. 20).

The bark and leaves of this tree are very astringent.

The bark has been shown to yield 18.4 per cent. of tannin, and the leaves 9.5 per cent.

This and other species of **Macaranga** yield a ruby-coloured styptic gum or kino which possesses peculiar properties (see *Agricultural Ledger No. 7 of 1900*).

MALLOTUS
PHILIP-
PINENSIS.**Mallotus philippinensis**, Muell.-Arg. (*Dict. Econ. Prod.*, M. 76).

The bark has been reported to be used in the North-West Provinces for tanning leather.

Professor Hummel found 6.5 per cent. of tannin in the dry, powdered bark, indicating an inferior material.

PHYLLAN-
THUS
EMBLICA.**Phyllanthus Emblica**, Linn. (*Dict. Econ. Prod.*, P. 634).

The fruit of this small tree is well known as the Emblic Myrobalan, and has acid and astringent properties which are utilised for dyeing and tanning, either alone or in conjunction with other substances. The dried pulpy portion of the immature fruit affords as much as 35 per cent. of tannic acid, but in a ripe state only traces of this principle are found. There is abundance of soluble non-tannins present, but there is much less colouring matter than in the bark.

Fruit.

Leaves.

The leaves of this plant are regarded as one of the best tans by the Bengal *Chamars*. Professor Hummel reports an estimation of 18 per cent. of tannic acid in the leaves. The decoction was pale yellow

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(D. Hooper.)

coloured and slightly turbid. They appear to contain some essential oil or fat. The leaves carefully dried and possibly ground might find a ready sale.

The bark is used for tanning in Travancore. An extract prepared at Dehra Dun from bark supplied from the Central Provinces, yielded 28·2 per cent. of tannin. The extract was highly coloured. A sample of the bark itself gave 12·66 per cent. of tannin with a high proportion of non-tanning soluble matters, and much colouring material was observed when an infusion was examined in a tintometer.

Phyllanthus distichus, Muell.-Arg. (*Dict. Econ. Prod.*, P. 627).

The bark affords about 18 per cent. of tannic acid and is used for tanning in South India.

Phyllanthus nepalensis, Muell.-Arg. (*Dict. Econ. Prod.*, P. 656a).

The bark of this Himalayan tree is used for tanning.

PHYLLANTHUS
EMBLICA.

Bark.

PHYLLANTHUS
DISTICHUS.

PHYLLANTHUS
NEPALENSIS.

URTICACEÆ.

Ficus (*Dict. Econ. Prod.*, P. 129-240).

The barks of most of the Indian fig trees are astringent and are sometimes used for tanning leather.

The following results were arrived at during my examination of the barks of the undermentioned species:—

	Tannin.	Extract.	Ash.
Ficus bengalensis , Linn.	10·9	17·2	8·2
„ gibbosa , Blume.	4·3	10·4	15·0
„ hispida , Linn.	2·1	11·7	13·6
„ glomerata , Roxb.	14·1	20·5	12·2
„ religiosa , Linn.	3·8	12·3	11·7

The leaves of the Smyrna fig. (**F Carica**, Linn.) contain only 1·6 per cent. of tanning matter and are a deleterious adulterant of sumach (*Perkin*).

JUGLANDACEÆ.

Engelhardtia spicata, Blume. (*Dict. Econ. Prod.*, E. 211).

Dr. Roxburgh states that the thick brown bark of this tree possesses much tannin and is reckoned by the natives as the best material they are acquainted with for tanning purposes.

Samples of extract prepared from the bark by Mr. W. F. Lloyd in the Tista Division, Bengal, in 1898, were extremely rich in tannin.

ENGELHARDTIA
SPICATA.

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JUGLANS
REGIA.

A representative specimen of the bark I found had the following composition:—Water, 13·9; tannin, 20; extract, 23·2; ash, 7·3 per cent.

Juglans regia, Linn. (*Dict. Econ. Prod.*, J. 65).

The bark and fruit pericarp of the Walnut are rich in tannic acid.

MYRICACEÆ.

MYRICA
NAGI.

Myrica Nagi, Thun. (*Dict. Econ. Prod.*, M. 870.)

The bark of this tree (*Kaiphal*, Hind.) is used as a tan in the North-West Provinces for fancy leather work, and is employed in native medicine as an astringent, carminative and tonic.

A sample of the bark from Bombay was found by the writer to yield 13·7 per cent. of tannin, 11 per cent. of moisture and 7 per cent. of ash. Dr. Leather examined at Dehra Dun a specimen yielding 13·3 per cent. of tannin with a rather high proportion of soluble non-tannins. Dr. Dymock prepared an extract from the bark which was hard and brittle, almost exactly like kino.

Professor H. R. Procter, Yorkshire College, Leeds, gives the following average of four analyses of the bark obtained from the neighbourhood of Simla:—

Tannin matters	27·3
Soluble non-tanning substances	7·9
Fibre and insoluble matters	52·3
Moisture	12·5
	100·0

(see *Agricultural Ledger*, No. 6 of 1897.)

CASUARINACEÆ.

CASUARINA
EQUISETI-
FOLIA.

Casuarina equisetifolia, Forst. (*Dict. Econ. Prod.*, C. 829).

The bark is used by fishermen in Madras for dyeing their nets.

Two samples of bark from Madras afforded 11·1 and 18·3 per cent. of tannin giving a blue-black precipitate with ferric salts. Professor Hummel found 7·5 per cent., in addition to a red colouring matter attracted by mordants. The decoction was of a deep reddish colour.

CUPULIFERÆ.

ALNUS
SP.

Alnus glutinosa, Linn. (*Dict. Econ. Prod.*, A. 792).

Alnus nepalensis, D. Don. (*Dict. Econ. Prod.*, A. 798).

The bark is used for dyeing and tanning either alone or combined with other substances to deepen the colour.

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Alnus nitida, *Endl.* (*Dict. Econ. Prod.*, A. 802).

ALNUS
NITIDA.

This bark is used for dyeing and tanning. A specimen examined at the Imperial Institute by Mr. R. L. Jenks, gave 7·6 per cent. of extract with 3·07 per cent. of tannin.

Betula utilis, *D. Don.* (*Dict. Econ. Prod.*, B. 501).

BETULA
UTILIS.

A sample of the bark yielded only 4·4 per cent. of tannin.

Castanopsis argyrophylla, *King*, (*Dict. Econ. Prod.*, C. 814 a).

CASTANOPSIS
ARGYRO-
SHYLLA.

An extract prepared from the bark of a tree named *Thitta* was received from Tavoy in Burma where it was said to be used by fishermen for dyeing nets. The vernacular name *thitta* has been referred to **Sandoricum indicum**, but on calling for a botanical specimen of the Tavoy plant the above-named species of **Castanopsis** was forwarded.

The bark of **Castanea vesca** of Europe contains 14 to 20 per cent. of tannin. It is not surprising therefore to find allied trees in India yielding astringent barks of economic value.

Fagus sylvatica, *Linn.*

FAGUS
SYLVATICA.

The bark is used in Persia for tanning.

Quercus spp.

QUERCUS
spp.

Professor H. Trimble in 1894 examined four samples of oak bark from India with the following results :—

	Moisture.	Tannin.	Tannin on dry.
Quercus glauca , <i>Thund.</i>	6·85	11·37	12·20
„ dilatata , <i>Lindl.</i>	6·81	7·40	7·64
„ incana , <i>Roxb.</i>	5·31	22·12	23·36
„ semecarpifolia , <i>m.</i>	7·04	7·99	8·60

The tannin in the four barks appeared to be identical with that of British and American Oaks.

The bark of **Q. lamellosa**, *Sm.*, is used in Sikkim for tanning. A sample from the Tista Division, Bengal, yielded moisture 11·3; ash, 7·5; extract, 22; tanning, 11·2; tannin in dry bark, 12·62 per cent.

An extract of the bark made in the Tista Division afforded half its weight of tannin calculated on the dry substance.

Quercus Pachyphylla *Kurz* (*Dict. Econ. Prod.*, Q. 64.)

The bark and acorns have been used as tanning substances.

Quercus Ilex, *Linn.* (*Dict. Econ. Prod.*, Q. 30).

The bark is used in France for tanning.

Salix tetrasperma, *Roxb.* (*Dict. Econ. Prod.*, S. 580).

SALIX
TEIRA-
SPERMA.

The bark of this species is feebly astringent. A sample examined

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at Dehra Dun afforded only 1·7 per cent. of tannin, associated with inert soluble colouring matter.

Willow bark is used for tanning in Russia, and probably other Indian species might be found to be more suitable than the above.

CONIFERÆ.

PINUS
LONGIFOLIA.

Pinus longifolia, Roxb (*Dict. Econ. Prod.*, P. 763).

The bark of the Chir pine has been used for tanning. The percentage of tannin in the bark has been recorded as 13·1 by Wardle in 1887, in a specimen from Hazara; Leather found 11·34, and Hooper 14·5 per cent.

Pine bark extract is employed in Europe as a complement to imperfect tanning materials such as chestnut wood and quebracho.

PINUS
KHASYA.

Pinus Khasya, Royle (*Dict. Econ. Prod.*, P. 757).

The bark is used as the above.

TAXUS
BACCATA.

Taxus baccata, Sinn. (*Dict. Econ. Prod.*, T. 95).

The Yew bark is astrigent and is said to be used in the Bhutea Parganas as a red dye. It is also said to be a substitute for tea leaves in making a beverage in Ladakh, and is imported into Leh from Kashmir and Kullu for this purpose.

Dr. Leather found 8·8 per cent. of tannin and 10·8 per cent. of soluble non-tannins in a piece of bark from the Himalayas. The large proportion of soluble inert matter would not render the bark suitable for a tanning extract.

PALMÆ.

ARECA
CATECHU.

Areca Catechu, Linn. (*Dict. Econ. Prod.*, A. 1300).

The Natives of India habitually chew the nut of the betel palm with slaked lime and spices as a stimulant. The nut, according to Hanbury and Flückiger contains about 15 per cent. of tannin, and from the recent researches of Jahns, contains one or more alkaloids of a stimulating nature. The addition of lime to the betel-nut during the process of mastication forms a soluble compound with the tannin of a deep red colour, and liberates the alkaloids from their natural combination. An astringent extract is sometimes prepared from the nut and is sold either in a solid or liquid condition. A chemical knowledge of the trade forms of betel-nut known in India is a desideratum.

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 ——— *tomentella*, 40.
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1902—No. 2.

ACACIA spp.

[*Dictionary of Economic Products, Vol. I., A. 100.*]

THE INDIAN ACACIAS.

By GEORGE WATT, M.B., C.M., F.L.S., C.I.E.

A review of available information written mainly with the object of bringing out the chief commercial facts regarding The Indian Acacias.

The genus *Acacia* is a genus of spinose or prickly climbing shrubs or trees which belongs to the Natural Order LEGUMINOSÆ, and constitutes the most characteristic group of plants in the Sub-order MIMOSÆ. There are in all 430 species, of which two-thirds are peculiar to Australia. India possesses only some 20 and these are distributed throughout the plains, two ascending to altitudes close on 5,000 feet. The reader should consult Major D. Prain's paper on *Some Additional Leguminosæ* (*Journ. Asiatic Soc. Beng., Vol. LXVI, 1897, pages 506-511*), for the most recent botanical opinion regarding the species of this genus.

It may, strictly speaking, be said that every Indian species is of economic value. Three are of Commercial Importance, viz., *Acacia arabica*, *A. Catechu*, and *A. Senegal*, while the remainder may be regarded as of very much less value, in other words as of local interest mainly. The bushy and arborescent forms, as a rule, afford astringent barks, leaves or pods and are appreciated as MEDICINES, as TANS or as DYE AUXILIARIES. Many of them afford useful GUMS that are more or less soluble and edible. Interesting particulars regarding the fungi that appear to be instrumental in the formation of these gums will be found in a paper written by Mr. J. B. Prebble, and published in the *Pharmacographia Indica* (*Vol. I., pages 544-55*); see also Masee's *Plant Diseases*, page 122. The BARKS of some species yield coarse cordage FIBRES. The majority of the trees are

INTRODUC-
TORY.

Indian
Acacias.

Commercial
Species.

Generic
Properties.

Gum.

Fibre.

A. 100.

ACACIA
concinna.

The Soap Nut.

INTRODUC-
TORY.Structure
of Wood.

Agriculture.

Hedges.

Fodder.

Acclimatised
Forms.ACACIA
CONCINNA.
Habitat.

Tan.

Soap Pod.

of the greatest value to the inhabitants of the tracts where they are at all prevalent both as sources of TIMBER and FUEL. With regard to the timber Mr. Gamble observes that the Indian species have sharp prominent medullary rays, which are short in *A. Catechu*, *ferruginea* and *modesta*, but long in the others. As a rule they are not well marked in radial section, but *A. leucophlœa* and *arabica* are exceptional in this respect—the former being beautifully marked. All the species of *Acacia* are recognised as of the utmost importance in AGRICULTURE, as, for example, in the reclamation of waste lands, indeed, as a rule, they are the chief trees and shrubs met with in certain arid regions. And lastly either as living hedges or as dead thorny fences their spinose property is much appreciated for the protection of cultivated lands, and the leaves beaten from the twigs afford a much valued FODDER to the cattle of the regions in which they are plentiful.

A few foreign species have become completely acclimatised in India, such as *A. dealbata*—the AUSTRALIAN SILVER WATTLE—and *A. melanoxylon*—the AUSTRALIAN BLACK-WOOD. These are fairly general in the warm temperate tracts of India, more especially in the Nilgiri Hills where they were introduced in 1840.

It may perhaps suffice to deal very briefly with the so-called unimportant species under the present generic position and to touch mainly on their special features of interest, leaving the above observations to be more or less applicable to all of them.

ACACIA CONCINNA, DC.; (*Dict. Econ. Prod. I., 44*).—A common prickly scandent bush met with in the tropical jungles throughout India. Since the pods are extensively used as a detergent, they are often confused with the SOAP NUT (*Sapindus Mukorossi*), and indeed they bear, as a rule, the same vernacular names, viz., *rita* or *ritha*. In Bengal the present plant is distinguished as the *ban* (wild) *ritha* and amongst others the following names are given to it in the provinces:—*aila*, *rassaul*, *sika*, *shika*, *sikekai*, or *chikakai*, or *chikaya*, *gogu*, *sige* (the unripe pod being *kayi*), *ken-bwon* or *kin-bun*, *suboknwe*. In Sanskrit it is spoken of as *Saptala* or *charma-kasa* (skin-injurer) in allusion to its numerous thorns.

The BARK of this bush is to some extent used as a TAN for fishing lines and is imported for this purpose into Bombay from Kanara. The chief interest in the plant proceeds, however, from the well-known DETERGENT property of the PODS. These have been extolled by every writer from the date when Ainslie and Roxburgh first made them known to the Western world. They are largely employed in washing silk and woollen goods, and it is believed some of the best tinctorial results are to be attained only with yarn washed by these

A. 200.

The Cassie Perfume.

(G. Watt.)

**ACACIA
FARNESIANA.**

Pods, previous to being dyed. They may be used with much advantage in washing tarnished silver plate, the objects attaining a brilliancy, on being rubbed up with a little chalk, hardly to be secured otherwise.

The **TRADE** in these detergent pods must be very considerable in India as a whole. Collective returns are, however, not available, but we read of from 10 to 135 tons being imported into Bombay annually and mainly from South Kanara. *The Madras Mail* (January 1898) speaks of the local supply coming from Palghat and Vaniembaby, and urges an effort being made to place these pods on the European markets.

A. FARNESIANA, Willd.; (*Dict. Econ. Prod. I.*, 48).—A small tree indigenous to India and cosmopolitan in the tropics. It is best known in Europe as **CASSIE FLOWER** and curiously enough is in India usually denoted by comparative or descriptive names such as *vilayati* (English) *babul* or *kikar*, *pissi-babul*, *gu-kikar*, *gaud-babul*, *gaya-babul*, *gandhi-babul*, *gabur*, *tal-baval*, *baver*, *kne-bawal*, *oda-sale*, *murki-tumma*, *naga-tumma*, *piktinni*, *kasturi-tumma*, *kampu-tumma*, *jali*, *nanlongyaing*, *hanlogyaing*, etc. Dutt mentions *arimeda* and *vitkhadira* as the Sanskrit names of this tree and Elliott calls it the *arimedamu*.

It is largely cultivated in France on account of the rich **PERFUME** obtained from the **FLOWERS**. In fact although it yields a **GUM** and other products similar to most species, the chief interest in this tree centres in its **CASSIE FLOWERS**. Sir F. A. Abel, Bart., K.C.B., in a letter to the Government of India, dated the 16th July 1894, gives the following interesting particulars:—

“In a note on drugs Mr. Umney mentions incidentally and in very high terms **CASSIE POMADE**, made in India. This was prepared by Mr. . . . of Naini Tal (recently deceased), who is believed to have been an engineer by profession, but who used to send to London supplies of **CASSIE POMADE**.

“Mr. Umney makes the following remarks respecting this pomade:—

““The planter who grew this root* sent also large consignments of **CASSIE POMADE**, the quality of which was excellent, and these have been continued and subsequent shipments made, but Mr. Umney learns that the planter referred to is now dead, and that his widow, who is at the present time in London, has given up the cultivation. It is a pity that the supply should cease, because from observations in the Laboratory of Wright, Layman and Umney, the produce from **CASSIE FLOWERS** grown in India was superior to that grown at Grasse, France; indeed Mr. Umney has been told that pomade was shipped from India to France, and subsequently shipped from Grasse to London, but of this he has no proof. His own opinion,

A. 217.

TRADE.Washing
Silver Plate.**Trade.****A.
FARNESIANA.**
Habitat.**Cassie
Perfume.****Indian
Cassie
Pomade.**

ACACIA Jacquemontii.

A Good Edible Gum.

CASSIE POMADE.

however, of the value of *CASSIE POMADE* is quite confirmed by the eminent firm of Schimmel & Co., Leipzig.'"

"Although there is a very full account of the *CASSIE FLOWER* (*Acacia Farnesiana*) in the *Dictionary of Economic Products*, Vol. I., page 48, et seq., where Piesse's opinion is quoted as to its value in perfumery, I have nevertheless thought it well to forward to the Government of India a copy of the opinion of Mr. Umney as to the excellence of the Indian product."

Although a good deal of attention has been given to this substance by myself and others, little progress has as yet been made toward establishing a trade in *CASSIE POMADE*. It is probable that in the plains of India a difficulty might be found to exist in preventing the lard or sweet oil, employed in the manufacture of the pomade, from becoming rancid. But in the lower hills or terai where this tree abounds or might easily be cultivated, a useful auxiliary crop to tea, coffee or even indigo might be found in *CASSIE POMADE*. For methods of cultivation and other details, *Conf.* with *Dictionary of Economic Products*, and *Odorographia* by J. C. Sawer, pages 114-16.

ACACIA JACQUE- MONTII Habitat.

ACACIA JACQUEMONTII, Benth.; (*Dict. Econ. Prod. I.*, 51).—Is a small thorny handsome shrub with stems and thorns polished and flowers sweetly scented; met with in the North-West Himálaya up to 3,000 feet in altitude. In the Punjab plains in Sind, in Rajputana and in North Guzerat it is often very abundant especially within water courses. It is known in Afghanistan as the *hanza*, but in the Punjab appears to bear, as a rule, the same vernacular names as *A. arabica*, although a sample recently came to the Office of Reporter on Economic Products from Amritsar under the vernacular names of *dhakki* and *chota-kikar*. In Rajputana it is called *baonli*; in Guzerat it is the *rato-baval*; in Baluchistan *har-barbara*; and in Sind *khunbut*. Captain M. A. Tighe, I.S.C., Political Agent, Southern Baluchistan, speaks of the gum of this tree as one of the spurious gum arabics which are known in that country as *khori-khor*. (*Report, dated 14th March 1898.*)

Fermenta- tion.

In addition to the generic properties already mentioned as possessed by most species, the ROOT-BARK is stated to be employed in DISTILLATION of spirit. For some years past a considerable trade from Baluchistan and Sind has been done in the GUM of this species, exported from Karachi. Stokes (speaking of Sind many years ago) says that it is inferior to gum arabic but it is used in MEDICINE, calico-printing, and in paper-making. Captain Tighe (to whom reference has already been made) has much to say as to the difference between this and the true gum arabic (the *khori-ka-khor*) which see under *A. Senegal*, and also under *COMMERCIAL GUM ARABIC*. But it may be

Gum.

A. 238.

Distiller's Bark.

(G. Watt.)

**ACACIA
leucophlœa.**

added in conclusion that Messrs. Rowntree & Co., Ltd., of York, have pronounced the Amritsar samples (mentioned above) as the best of the series of Indian gums examined by them for the confectioner's requirements. "It is strongly mucilaginous and forms a thin jelly on standing with 10 parts of water. The solution is brownish but fairly free from sediment and the flavour is sweet." It has been ascertained that about 35 cwt. of this are annually procurable in Amritsar.

GUM.
Suitable for
Confectionery.

ACACIA LEUCOPHLEA, Willd.; (*Dict. Econ. Prod. I.*, 52).—

A. LEUCOPH-
LEA.
Habitat.

A large deciduous fast-growing tree found in the plains of the Punjab and Rajputana, the forests of Central and South India and Burma. It prefers a low-lying situation and in the Punjab its presence is regarded as significant of a rich soil. Its branches are often disfigured by large excrescences. It is best known as the *safed kīkar* or white *babul*, but in every province it has numerous vernacular names, of which the following selection may be made:—*Reru*, *raunj*, or *ronj*, *raundra*, *reunjah* or *ronja*, *rinjra* or *rinz*, *nimbar* or *nunbar*, *karir*, *jand*, *goira*, *arinj*, *topal*, *tumbe*; *tumma*, *hewar*, *hivar*, *haribaval*, *velvelam*, *tella-tuma*, *bili-jali*, *tanaung*, etc. etc.

In addition to the general properties possessed by most of the species of *Acacia*, Mr. J. G. Prebble says that it yields a GUM readily soluble in water and forming a good thick pale-coloured mucilage, possessed of the somewhat peculiar property that it is gelatinised by borax but is unaffected by ether, neutral or basic acetate of lead or perchloride of iron. It seems probable that owing to its close chemical affinity this gum is often largely used to adulterate the better qualities of *GUM GHATI* of commerce. The BARK affords a strong FIBRE said to be much valued for fishing nets. Ground to a powder it is sometimes eaten mixed with *bajra*, especially in times of scarcity. It has also attained a considerable reputation as an astringent used in alcoholic DISTILLATION. On this account it is often called *sharab-kī-kīkar* (spirit-*Acacia*). The tannin precipitates the albuminous substances present in the saccharine juices, facilitates fermentation and is said to give a pleasant astringent flavour to the beverage. In the Southern Mahratta country the trees are farmed out by Government in consequence of the value of the bark. A distiller in South India recently informed me that he would use this bark more extensively than at present, were it possible to obtain a guarantee of quality. He held that while most *Acacia* barks might be employed in fermentation, that of the present species was so much superior to all others as to justify its being called "*THE DISTILLER'S ACACIA*."

Gum.

Fibre.

Food.

Fermenta-
tion.

ACACIA MODESTA, Wall.; (*Dict. Econ. Prod. I.*, 53).—Is a moderate sized tree found in the Saliman and Salt Ranges, the

A. MODESTA.
Habitat.

A. 249.

ACACIA
modesta.

Amritsar Gum.

AMRITSAR
GUM.

Sub-Himalaya—between the Indus and Sutlej—and is one of the characteristic trees of the Northern Punjab plains. It grows readily in poor sandy or rocky soils. But curiously enough it is also found occasionally in very damp situations. Is a slow grower and in consequence not often planted, except as a fence for which it is peculiarly suited. It is perhaps best known by its Punjabi names of *phula*, *phulai*, *phulahi* and *bhamburi*, but it also bears the vernacular names of *kantosariyo* and *palosa*.

Gum.

It yields sparingly a very useful GUM which occurs in small round tears or angular fragments with a few vermiform pieces marked with waved transverse lines. Mr. Prebble says, "It is translucent and of a yellowish colour; very soluble in water, forming a good pale-coloured mucilage. With basic acetate of lead and ferric chloride it forms a jelly but not with borax; with neutral acetate of lead a faint precipitate or cloudiness and a slight reduction with Fehling's solution. The gum is sent to Bombay from Northern India and is classed by the merchants as *AMRITSAR GUM*. The Punjab supply comes mainly from the Rawalpindi and Jhelum districts. In Northern India it is largely employed in MEDICINE. The tree affords also a very beautiful strong and durable TIMBER which is largely employed for cart wheels, sugar-cane crushers, agricultural implements, etc. The soft delicate twigs are employed as *tooth-brushes* especially in the Punjab.

Amritsar
Gum.

Timber.

A. PENNATA.
Habitat.

ACACIA PENNATA, Willd.; (*Dict. Econ. Prod. I.*, 54).—Is a large climbing shrub of the Sub-Himalaya, East Bengal, South India and common all over Burma. It is the *biswul*, *arar*, *shemb*, *undaru*, *gurwa*, *agla*, *awal*, *arfu*, *tolrik*, *thembi* and *su-yit*, etc. The BARK is an article of commerce, being exported from the Concan, and used to TAN fishing nets in Bombay.

Tan.

A. SENEGAL.
Habitat.

A. SENEGAL, Willd.; (*Dict. Econ. Prod. I.*, 55).—A low tree with grey bark and flexuose branches; met with, so far as India is concerned, in Rajputana and Sind, more particularly in the Las Bela country.

It yields the *TRUE GUM ARABIC* of European Commerce, and is known as *khore* in Sind (*khore-ka-khore* in Las Bela); and *kumta* in Rajputana.

For further particulars consult the chapter below devoted to "*COMMERCIAL GUM ARABIC*," p. 74.

A. SUMA.
Habitat.

A. SUMA, Buch.-Ham.; (*Dict. Econ. Prod. I.*, 60).—Is a medium sized tree with white bark (a circumstance that gives origin to most of its vernacular names) and is common in Bengal, Behar, Assam and South India from the Carnatic to Mysore. Seems to luxuriate on moist soils in such places as vicinity of tanks, canals or streams. It

A. 261.

Indian Gum Arabic.

(G. Watt.)

ACACIA
Suma.

is known as the *sai-kantz kumtia*, *dhaula* (white)-*khejra*, *gorado*, *sonkairi*, *gonharee*, *tella-sandra* (or *chandra*), *mugalisoppu*, *bannimara*, *mugli*, etc. Dutt says it is the *sami* of Sanskrit and the *sain* of Bengali and *chhikura* of Hindustani.

It possesses most of the generic properties mentioned above, but through being confused with *A. Sundra* (which see under *A. Catechu*) has by some writers been incorrectly spoken of as a catch-yielding species.

ACACIA ARABICA, Willd.; (*Dict. Econ. Prod. I.*, 17).

This is the **INDIAN GUM ARABIC TREE** which, over the greater part of India, is known by the names *Babul* or *Kikar*. Dutt (*Hindu Mat. Med.*) gives it the Sanskrit name of *Vavula* or *babula* (a word which according to Rice is only Sanskritised), while Sir Walter Elliot (*Flora Andh.*) says it is the *Barbúrama* of Sanskrit. In South India it is known as *karú* (or *karuvelam*), *gobli*, *jáli*, *tumma*, etc.

Habitat.—It is one of the most widely distributed and prevalent of small trees in India but chiefly on village sites, borders of fields or waste lands. It prefers a dry to a moist climate and accordingly is, as a rule, absent from the coast tracts; it disappears gradually from Bengal, Behar and Oudh, on the Terai being approached; is absent from the warm moist tracts of Assam, Manipur and Burma; is most prevalent from the North-West Provinces, through the Central Provinces to Berar, Central India, Bombay and Sind; and might be said to attain its greatest development in lower and middle Sind, where it is probably truly indigenous. It would not appear to be a native in many parts of India where it is nevertheless prevalent (such as the Punjab, Oudh, Bengal and Madras).

Varieties.—Some short time ago Sir Dietrich Brandis, K.C.I.E., (*Indian Forester*, Vol. XXIII., September 1897, page 359) raised the question of the varieties of this species. He refers to the *kaulia babul* of Berar as a small tree with deeply cracked and exfoliated bark, broad marginate pods, and stouter spines than the ordinary form which in Akola is distinguished as *telia babul*. A third variety is the cylindrical *babul* known as *ram-kanta*. The *kaulia* or *kauria* is a smaller tree, grows on poorer soil, and affords a much less valued timber than the ordinary or *telia babul*. Sir Dietrich then offers the suggestion that the *kaulia babul* may be only a hybrid between *A. arabica* and *eburnea*. In 1869 Stewart expressed the opinion that the variety *A. spina-alba* of Griffith, Jameson and Aitchison was no true variety but merely a long spined condition produced after being heavily pruned.

Shortly after Sir Dietrich Brandis' paper appeared, two Officers of the Forest Service took up the subject and confirmed his observations. Mr. R. Fagan wrote that he had been familiar with both *kaulia* and

BABUL.

A. ARABICA.
The Babul
or Kikar.A tree of
Village Sites.Kaulia and
Telia Babuls.

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ACACIA arabica.		Cultivation.
BABUL.		<i>telia babul</i> for the past 20 years and that they were distributed from Berar through Khandesh to Satara. In the Deccan the <i>kaulia</i> (or <i>kowri</i> or <i>kaoria</i>) becomes the <i>vedi</i> or <i>vadi</i>, i.e., the mad <i>babul</i>, and the <i>telia</i> is the <i>godi</i> or sweet <i>babul</i>. In 1884 both Mr. Shuttleworth and Mr. Woodrow had alluded to these three <i>babuls</i>, only that the former came to the conclusion that the <i>vadi babul</i> was in reality <i>A. Farnesiana</i>. The cylindrical <i>babul</i> or <i>ram-kanta</i> is referred to by many persons and is believed to be the so-called Kabul <i>babul</i> of the Punjab or as it is sometimes called the cypress <i>babul</i>.
Vedi or Mad-babul.		
The Godi Babul.		
Conclusion regarding variety.		It would seem that the well known variability of <i>Acacia arabica</i> in merit of gum, tan and timber afforded, may to a large extent be dependent on this question of the varieties or climatic conditions of the species, hence this subject is well worthy of more careful consideration.
Soil.		Soil.—According to most observers it prefers a sandy light loam or black cotton soil to heavy clay, but appears to be somewhat indifferent to the presence of a fairly large percentage of <i>reh</i> or <i>shor</i> (efflorescent salts). But it does not succeed either on rocky and hilly ground or on low-lying and submerged tracts. On poor soils it may be grown as a means of reclamation, but plantations to be made profitable must be on fairly good soils. The yield and quality of the gum, of the tanning bark and of the timber—its three chief products—greatly depend on the healthy condition of the plants.
Successful Cultivation.		Enemies.—The life of the tree is generally said to be about 20 or 30 years ; at all events after then it would seem to be very much addicted to the ravages of various pests among which the grubs of one or two longicorn beetles may be specially mentioned. Mr. Stebbing (<i>Injurious Insects of Forest Trees, pages 67 and 69</i>) describes these as <i>Cælosterna spinata</i> and <i>Pachydissus holosericeus</i>. Its greatest enemy, however, (especially during the first 3 to 5 years of its existence) may be said to be the goat.
Longicorn Beetles destructive.		
Methods of Sowing.		Method of Cultivation.—It is raised from seed, bears transplanting indifferently, but according to one writer in South India may be propagated by cuttings. Stewart made the same observation in 1869, viz., that in the Gangetic Doab it is raised from cuttings. It can be drill sown or broad-casted, in either case just before the rains or, say, in June to July. It germinates slowly, as the seeds are exceedingly hard. Accordingly it is customary to soften them by steeping for a day or so in water or in liquid cow manure. The seed is generally gathered in April, and by the Native cultivator is often coated with cow-dung and kept in that condition till July when it is sown on the spot where it is intended to be grown. Most writers affirm that germination is best effected by making goats or sheep first eat the seeds. This is, however, a mistake, for these animals will not eat the
Season.		
Methods of Germination.		

Cost of Production.	(G. Watt.)	ACACIA arabica.
shelled seeds and do not care much for ripe pods; they prefer green pods with immature seeds. When the seeds are mature they eject them from the mouth during rumination, and the seeds thus never actually pass through the alimentary system. Having, however, been retained, perhaps for some hours, in the first stomach of a ruminant they will be found to germinate freely.		CULTIVATION.
The plants have to be weeded and thinned out till the third year when the healthiest only should then occupy the ground at distances of from 10 to 15 or even 20 feet apart. In the third year they will flower and bear fruit and, according to the experts of the tanning industry in Cawnpore, the bark is in its most perfect condition when the trees are from 4 to 6 years old. Curiously enough many of the Native opinions recorded in the papers in my hands affirm that the older the trees the stronger the tanning property. This would appear to be a mistake, the colouring principle develops, but the tanning value decreases with age. If, therefore, <i>babul</i> plantations be raised, with a view to returns from tanning-bark and fuel, the maximum age to uproot should be from 6 to 10 years.		Weeded out.
		Perfect Condition of Bark.
		Proper Age of Plantations.
At one time it was supposed that a system of pollarding a plantation might be the most remunerative, but plants so treated have been observed to grow so very slowly afterwards that it has been concluded the preferable course is to uproot and replant. In localities where bark is not very largely in demand it is sometimes stripped off the living plants, but the wounds heal so very badly that this is by no means an approved method of procedure.		Pollarding Plantations.
		Stripping Bark.
Cost of Production and Profit. —Mr. Ozanne (<i>letter No. 607, dated July 1884, para. 16</i>) furnishes returns given by a Parsi gentleman of Guzerat. Briefly these may be said to show the cost of cultivation and rent of an acre of land for 10 years as ₹24 . Gross proceeds for grazing and fuel ₹251 , thus leaving a net profit of ₹227 . Dr. Leather (<i>The Agricultural Ledger, No. 18 of 1896, page 4</i>) shows the working expenses for an acre of land in Agra under <i>babul</i> to have come to ₹146 and the gross receipts ₹440 so that the net profit in 10 years came to ₹294 . But in neither of these cases does credit appear to have been made for the sale of bark, the plantations having apparently been undertaken purely and simply for fuel purposes. Reference will be found below to the Unao plantations under the paragraph devoted to agriculture, page 73.	Cost.	
		Profit.
The voluminous papers at my disposal manifest the following particulars that have a bearing on the question of profit in cultivation. In Bengal a full grown tree (20 years old) may fetch ₹4 . In the North-Western Provinces (in the vicinity of Cawnpore) a tree 6 years old would realize ₹3 , but less at a distance from that town. In the Central Provinces each tree is valued at ₹2 to ₹4 according to		Cost of Trees.

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ACACIA arabica.		Cost of Production.
BABUL.		size and quality. In Rajputana and Central India the majority of the reports to hand would seem to denote a much higher valuation, namely, R15. In the Punjab a wide range has been recorded from R8 in Multan to R50 in Delhi, but all the Punjab papers speak of a full-grown tree being from 40 to 60 years of age and as yielding fairly large and much valued timber. It is admitted that trees from plantations only 10 to 15 years old might not realize more than one rupee each. In Bombay Presidency a similar valuation is given to that of the Punjab; very old trees perhaps 50 or 60 years of age with useful sizes of timber would fetch from R40 to R100 each. Mr. Shuttleworth says an acre of land specially grown for fuel supply might give an annual net profit of R12 and might continue to do so for 40 years. In Berar the returns indicate an average value of R2 to R4, though as much as R20 has been known to be paid for old trees. They are believed to attain full growth in 20 years. In South India (Northern Forest Circle) well-grown trees of 40 to 50 years are believed to bring as much as R30 to R40 or even up to R100 each. It may thus, in conclusion, be said that on good soil the tree is much less gregarious, is allowed to grow to a fairly large size and is accordingly valued more as a timber tree than as a source of fuel. The variety (mentioned above) as <i>kaulia</i> or <i>vadi</i> is that usefully grown in Berar and Western India when fuel only is desired. The <i>telia</i> or <i>godli</i> is the form that is ordinarily allowed to run to timber. Success in cultivation would seem to depend upon several circumstances such as the scarcity of, and consequent high price of fuel: a good market for the bark: the existence of suitable land at low rents, etc., etc. If other fuel be fairly plentiful or if cheap waste lands be not available, the tree takes its place on the margins of fields and roadsides more as a source of timber and gum, than of fuel and tanning bark, and the <i>telia</i> variety would be that most generally met with under such circumstances. But it must never be lost sight of that, to be successful, production of <i>babul</i> fuel and <i>babul</i> bark must be in close proximity to the markets, since neither product could bear heavy railway freights. So also it may be added that in fuel-yielding tracts (or plantations) gum is rarely produced to any appreciable extent; the supply of that product has to be looked for mainly from the more natural habitats of the plant, especially the arid tracts of its indigenous distribution as a forest tree. The products and uses of Babul may be dealt with under the following headings:—
Age of Babul.		
Price of Babul Trees.		
Profit of Fuel Cultivation.		
Babul Timber.		
Success in Cultivation.		<i>Ist.—THE GUM.</i> GUM exudes in March, April and May, according to the vast majority of reports, but in connection with Amritsar it is said that
Gum Rarely Obtained.		
GUM. Seasons of Flow of Gum.		

Varying Quality of the Gum.	(G. Watt.)	ACACIA arabica.
it oozes from the trees in the months of October, November and December. A tree yields a maximum of about 2 lbs. a year, but the average might be more safely put at a few ounces. In certain localities little or no gum is given by the trees and seasonal variations in yield are also well-known and are said to be dependent on abnormal climatic conditions. It is generally believed that the flow is accelerated on the trees being tapped, still this is only very occasionally done, and, when practised, may be detected by the presence of long stalactiform masses.	GUM. Yield of Gum Accelerated by Tapping.	Appearance of Gum.
The gum occurs in the form of irregular and broken tears, agglutinated into masses, each tear being $\frac{1}{2}$ an inch in size and of a pale straw colour to red, brown or almost black, according to the age of tree on which found. The older the tree the higher the yield, but the darker the colour and the poorer the quality of gum. That is the general opinion, but the Amritsar report states that old trees do not yield any gum at all. Long exposure to the atmospheric influences, more especially to damp and rain, darkens the colour and lowers the value of the gum besides making it astringent, from the quantity of tannin with which it becomes charged. It has also been observed that gum exuding from gnarled stems or diseased portions is dark coloured.	Atmospheric Influence.	Dark Coloured Gum.
The purer and paler coloured samples reduce Fehling's solution only slightly, and are darkened in colour by ferric chloride and gelatinised by borax. The darker coloured samples (highly charged with tannin) are precipitated by basic acetate of lead, form inky colorations with ferric chloride, deep brown with bichromate of potash and red with molybdate of ammonia. They freely reduce Fehling's solution. Moreover, the darker coloured portions are much less soluble in water and leave a gelatinous portion undissolved.	GUM. Chemical Reactions.	
Indian gum arabic is used in calico-printing and in all other industries where a mucilage is necessary and in which the peculiar properties of this particular gum are recognised as specially suitable. Among other minor purposes it is, for example, employed as an ingredient in white-wash and in paints used for wall-distemping. It is added to certain mortars and to paints that are used for clay toys. As a MEDICINE it is an indifferent substitute for the true gum arabic of European pharmacy (see the article below). Still when fairly pure it may be said to be regarded as demulcent and to be suitable for use as a vehicle for bismuth, oxide of zinc and other insoluble substances. It is often used as a vehicle for castor oil and has the merit of absorbing the offensive smell. One drachm of gum dissolved in $\frac{1}{2}$ oz. of water will carry 1 oz. castor oil. Employed in lozenges its very much lower solubility than the true gum arabic tells distinctly against it.	Industrial Uses. Medicinal Uses.	

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ACACIA arabica.	Price of the Gum.
BABUL. Famine Food	It used to be affirmed that in times of scarcity the gum formed an important item of human food, but recent inquiry has brought a flat contradiction of that statement from almost every district in India. The gum at all seasons is several times more expensive than the grains eaten by the poorer people; they would, therefore, preferably purchase grain with it. It is nowhere so abundant as to become a famine food. It is, however, unquestionably edible, and fried with ghi, sugar and spices, it is very largely employed in the preparation of certain Native sweetmeats which are very generally eaten after child-birth.
Sweetmeats.	The investigations so far as they have proceeded into the Indian gums suitable for the European confectionery trade, have revealed several very surprising circumstances connected with this gum. There are, for example, great variations in quality which are not alone accountable for by adulteration with inferior gums. Not only does the quality depend largely on the age of the trees and the variety of tree, but on the province in which procured. Thus, for example, two samples, one said to have been the best quality from Nagpur, and the other from Cawnpore (both believed to have been authentic samples of <i>Acacia arabica</i> gum), were forwarded to Messrs. Rowntree & Co., for examination and report. The reply in due course came—"They gave exceedingly dark solutions of medium strength, but both are quite useless to us on account of the colour." A third consignment procured from the Punjab was said to give "a pale solution, very thin and probably of little value for any purpose." The best edible gum, from Messrs. Rowntree & Co.'s standpoint, is that already referred to under <i>A. Jacquemontii</i>. It would thus seem that so far from <i>Acacia arabica</i> affording the best gum arabic of India, it might almost be described as the least important species of the genus, from the point of view of an edible gum. But it seems probable that <i>babul</i> gum from Sind may be of a much superior quality to that from other parts of India. This subject has by present inquiry been by no means exhausted. Much has still to be learned regarding the variations in quality and best localities of supply. As met with in trade the gum comes mainly from the Central Provinces and Berar and is known in Bombay as <i>Umravatti</i> and <i>Amrad</i>.
Confection- ery Trade.	Price.—The information available regarding the price at which the gum can be procured is so conflicting as to be practically worthless. At Bilaspur (landed at the nearest railway station) the price would be ₹25 per 100 lbs., while at Nagpur only ₹12-8. At Shahpura the gum is said to cost about ₹20 per 100 lbs. Of Lahore it is reported that local production hardly suffices to meet the demand and that it sells for from ₹18 to ₹24 per 100 lbs. In Amritsar it is
Best Edible Gum.	
Umravatti Gum.	
PRICE OF GUM.	

A. 101.

ACACIA arabica.	Price of Bark.
BABUL. Cannot be Exported.	in Europe, and that very possibly it will never even pay to manufacture for export a tanning extract from this bark or from the bark and pods combined. Much has been written on this theme, but it may be said the claims of <i>babul</i>-bark turn, on its cheapness and abundance, but it is bulky, and the percentage of tannin small, hence it cannot be profitably carried for more than short distances. Accordingly it may be said that <i>babul</i>-bark is a tanning material of great local value, but one that is hardly even likely to be exported to foreign countries. It contains 18.95 per cent. of a tannin which is of a beautiful cream-colour when precipitated with gelatin. Price and Supply.—Very little of a definite nature can be published on these subjects. It has been reported recently that the annual consumption in Cawnpore alone is over 200,000 maunds, valued at eight annas a maund. But Cawnpore is the great tanning centre of India and its transactions represent, therefore, a very large slice of the total traffic in the bark. At Dumraon in Bengal, <i>babul</i>-bark is said to be sold at ₹1-10-0 per 100 lbs. At Bundelkhand it can be had for 6 annas a maund. In the Central Provinces the bark is valued at ₹1-4-0 per 100 lbs., while at Shahpura in Rajputana the same quantity costs ₹2-4-0. At Lahore it is said the annual sales of bark average 4,000 maunds at 8 annas a maund. Mention is made of 1,500 maunds as the Delhi supply and that it there sells at 13 annas a maund. At Poona the bark fetches 12 annas to ₹1 per 100 lbs. These and such like are the returns that have come to hand, and they afford very little of a trustworthy nature, further than that it is a local product that in point of price is, like most other commodities, influenced by the laws of supply and demand. As with most other species of <i>Acacia</i> the bark is employed in FERMENTATION, hence some of the reports speak of it as affording Yeast. Some 2 to 3 seers of the crushed bark are required for one maund of <i>gur</i> (undrained sugar) or <i>shira</i> (molasses) and 3 maunds of water. This mixture has to be kept for 7 or 8 days in summer or for a few days longer in winter, before fermentation is complete. But it seems to be generally admitted that for this purpose <i>babul</i> bark is much inferior to that of <i>A. leucophloea</i>. A distiller in South India informed me that the chief obstacle to an extended use of <i>Acacia</i> bark was the difficulty in procuring the right kind in sufficient quantity. <i>Babul</i>-bark is extensively employed as an astringent MEDICINE. As a substitute for Oak-bark and galls in external application it would seem fairly satisfactory. The bark boiled in soap and water is a useful preparation in which to wash dogs, horses, etc. Reduced to ashes it forms a useful tooth-powder.
Percentage of Tannin.	
Local Prices.	
Fermenta- tion.	
Medicine.	
Tooth Powder.	

A. 101.

Tanning Pod.	(G. Watt.)	ACACIA arabica.
3RD.—THE POD.		PODS.
The PODS attracted much attention in the 1884 inquiry on account of an absurdly high valuation as a tanning material having been attributed to them. It was then affirmed that the crushed pods freed from seed would fetch £40 a ton or 50 per cent. more than was then being paid for oak-bark! This naturally led to numerous experiments being performed to test the yield per acre, the cost of production and methods of crushing and baling the material. When the report called for finally came to hand from England, <i>babul</i> pods ceased to attract attention; they contained at most 9½ per cent. of tannin and could not bring £10 a ton. All interest in the subject died as quickly as it had burst into spurious attention. <i>The Agricultural Ledger No. 9 of 1896</i>, may be consulted for further particulars.		Spurious Repu tation.
But crushed <i>babul</i>-pod imparts a beautiful colour to leather, and on that account mainly it enjoys a certain local reputation as a weak tanning and dyeing material to be used in conjunction with other substances. At the Cawnpore Tanneries the pods are used almost exclusively for the purpose of removing the lime from skins and hides preparatorily to being tanned with <i>babul</i>-bark or other substances. The dyers of India often employ <i>babul</i>-pods for certain shades that are admired in calico-printing.		Uses.
From the immature pods by inspissation, an extract may be prepared. This was known to the ancients and through the Greeks reached the Arabs to whom it was known as <i>Akakia</i>. To this day a DRUG comes to India under that name from Turkey and Persia and is sold by most Muhammadan druggists. It is considered cold and dry, astringent, styptic and tonic, and is used both internally and externally in relaxed conditions of the mucous membranes and as a collyrium in purulent conjunctivitis and chronic congestion of the vessels of the conjunctiva. Applied as a lotion to the face it is believed to improve the complexion.		Medicine.
The unripe pods, reduced to a powder, are used as a domestic medicine in all cases where an astringent is indicated. They are employed in the manufacture of tooth powder and along with sulphate of iron in the preparation of ink.		Akakia.
The tender young pods are EATEN as a VEGETABLE, especially in times of scarcity. They are often pickled (<i>achār</i>) and viewed as a luxury, especially by the Marwaris: The green pods with their seeds are regularly eaten as FODDER by goats, sheep, cows and camels. By most persons they are said to be strengthening and to be especially useful as an occasional diet for milch cattle. But if fed on them for any length of time, the pods are supposed to become injurious. From Madras has been received the statement that fatal cases have		Cosmetic.
		Tooth Powder. Ink. Vegetable. Pickle. Fodder.

A. 101.

ACACIA arabica.	Tanning Leaves.
BABUL. Dangerous to Cattle at times.	been known to occur from cattle eating the seeds. In Sind the green pods are much appreciated, as may be learned from the following passage from a report by Lieutenant-Colonel J. G. McRae (dated 1884):—
Much Valued.	“ <i>Acacia arabica</i> yields a very abundant crop of legumes in the early part of the hot weather, during April and May, the sale of which forms an important item in the forest revenue in this Province. It is quite impossible to estimate the quantity of babul pods the forest yield yearly, as they are disposed of by giving yearly leases of the forests for the right of gathering the pods for cattle fodder, and as the cattle in this district depend very greatly on these babul pods for green food, and often food of any kind, during the hottest and driest season of the year, I trust no facilities will be given, in diverting this important, I may say indispensable, fodder-supply from the use to which it is at present put.”
LEAVES OF A. ARABICA.	4TH.—THE LEAVES.
Tan.	Most of the older writers speak of the LEAVES of this tree being also used as a TAN, but according to the voluminous opinions recently to hand this would appear to be a mistake. They are sometimes used in DYEING and are often also employed in the manufacture of ink so that they do possess tannin, but in such small quantity to be useless as a tan. A few writers speak of the leaves, pods and bark being used conjointly by certain Native tanners, but apparently only when they are unable to procure enough of the bark to be employed by itself.
Dye.	
Ink.	
Fodder.	The chief value of the leaves is as a FODDER, especially in times of scarcity or famine. Beaten from the lopped and dried spinose branches they are regularly given to cattle. Although the tree is never leafless, fresh foliage appears from February to April. The value of this source of fodder when rain fails cannot be overstated as the tree is little, if at all, affected in its production of foliage by failure of rains.
Medicine.	In MEDICINE the leaves also find a fairly well recognised position. They are employed (as also the fresh juice expressed from them) in diarrhoea and dysentery and in the early stages of gonorrhoea. A paste of the leaves is employed in ophthalmia and it is also very frequently used as a stimulating application to ulcers.
Madak.	The leaves constitute an ingredient in the intoxicating drug of Indian-hemp known as <i>madak</i> , and it is said that in a similar way they are also made up with opium. One writer speaks of them as smoked like tobacco but doubtless only in some such intoxicating preparations as those already mentioned.
TIMBER OF A. ARABICA: Agricultural Implements.	5TH.—THE TIMBER.
	This TIMBER is highly appreciated for all forms of agricultural implements because of its hardness and durability. It is specially valued for CART WHEELS. In Bengal, the North-Western Provinces

The Timber.	(G. Watt.)	ACACIA arabica.
and the Central Provinces the timber is rarely, if ever, employed in house construction or for furniture, as it is supposed to be a very unlucky timber. But in the Panjab, Sind and Bombay no such superstition exists, and accordingly it is frequently utilised in house building and is much appreciated where great strength is desired. In Bijapur it is much in demand for the construction of the carts for which that town is famous. When used for furniture the timber is carefully seasoned in water. As a source of FUEL OR CHARCOAL <i>babul</i> justly holds a high position in popular favour. Accordingly its cultivation in the vicinity of all large towns would seem highly profitable. An average sized tree will give 5 maunds of fuel besides branches and bark that fetch additional returns. Some few years ago a scare was started by the Madras Railway that <i>babul</i> fuel injured the boilers. This point has been freely discussed in the papers on my table. The practical result may be said to be the conclusion that as compared with coal all forms of wood fuel are injurious, but that <i>babul</i> timber has so high a calorific value that it is not only extensively used at the cotton and other mills and railways of Upper India, but would be more extensively employed were it procurable. 6TH.—MINOR INDUSTRIAL AND AGRICULTURAL USES. Mention has been made of babul gum being used in the manufacture of wall distempers, in paints; and of the pods and leaves being employed in ink, in tooth-powders, etc., but one of the most widely known of the minor uses of the plant is as tooth-brushes. Short twigs are made up into small bundles of about 100 each and in that form are exported as a regular article of trade from Karachi to Bombay and practically all over India. They are very extensively in demand by the Marwaris; the end is chewn until it forms the brush. Baskets are also plaited of young green babul twigs, and very strong and durable they are. Fishing traps are in some parts of the country similarly constructed of them, and the spines are occasionally employed as fishing hooks and as pins to sew together leaves used as platters. Crude ropes are sometimes made of the bark fibre, and in Poona it is said the fibre from the root is specially prepared to ornament the horns of bullocks during the <i>palwa</i> festival. In Sind (and to some extent also in the Panjab) <i>babul</i> is one of the important trees on which the Lac insect is reared. The reader will find full particulars on this subject in <i>The Agricultural Ledger</i>, No. 9 of 1901. To the Indian cultivator <i>babul</i> is of the greatest possible value. It does not afford much shade, and yet curiously enough very little, other than grass, will grow underneath it. On this account it is rarely, if ever, allowed to get established in the middle of fields.		TIMBER. House Construction, Method of Seasoning. Fuel.
		MINOR USES OF A. ARABICA.
		TOOTH BRUSHES. BASKETS. FISHING HOOKS. FIBRE. LAC. AGRICULTURE. Shade.

ACACIA
Senegal.

Commercial Gum Arabic,

TRUE GUM
ARABIC IN
RECLAMA-
TION OF
WASTE
LAND.

For avenue purposes, where shade is desired, it is not accordingly a desirable tree. But in the reclamation of waste lands *babul* is invaluable especially where *reh* efflorescence gives cause for anxiety. Grass rapidly becomes associated with it so that grazing affords a distinct source of revenue in *babul* plantations. In the *Indian Forester* (Vol. XXVI., April 1900) Mr. B. Ribbentrop, C.I.E., gives some interesting particulars regarding the *babul* plantation at Abbaspur near Unao, organised by Mr. Moreland, Director of Agriculture in the North-Western Provinces and Oudh. This was laid out for reclamation purposes, namely, on a shallow surface soil underlaid by clay or *kanker*, impenetrable to the tap-root of the tree. Pits were dug through the impenetrable layer, fresh soil was supplied and trees planted. This came to a cost of 10 annas each, but apparently so great an outlay stands every chance of proving a financial success. The land was otherwise useless and at the time of inspection the trees looked fairly healthy.

Hedge.
Fences.

Sown thickly as a hedge, *babul* forms a great protection both against animals and parching, dust-laden winds. As dead fences, the spiny boughs are universally employed to afford temporary protection to valued crops. For these and such like reasons extended cultivation of this tree should invariably be commended in all suitable localities.

A. SENEGAL.

ACACIA SENEGAL, Willd. (*Dict. Econ. Prod.*, I., 55-56).—**THE COMMERCIAL GUM ARABIC.**

COMMERCIAL
GUM.

Before concluding this brief review of *Acacia arabica* it seems desirable to bring together a few of the more important facts known regarding India's participation in the world's supply of **GUM ARABIC**. But let it be premised that it is an unfortunate circumstance that Arabia has become associated with this gum, since no portion of the commodity comes from that country and, moreover, the species that bears the name *arabica* is perhaps the least important of the gum-arabic-yielding plants. There may be said to be three chief forms of this gum:—1st, **TRUE GUM ARABIC OF EUROPEAN COMMERCE**; 2nd, **THE EAST INDIA GUM ARABIC**; 3rd, **THE INDIA GUM ARABIC** often collectively called "**GUM GHATI**." **THE TRUE GUM ARABIC** is obtained from *A. Senegal*, Willd., and there may be said to be three forms of it:—

Three Forms,

Gum Senegal.

1st: True Gum Arabic.—(a) *Gum Senegal* the *verek* of the Negros. This comes from the French Colony of Senegal (on the West Coast of Africa). It is collected after the close of the rains in November up till July. It is found to exude in greatest abundance during the dry desert winds and is most frequent at the bifurcations of the branches. The gum is shipped chiefly to Bordeaux. It is usually of a yellowish to a reddish colour and occurs in larger lumps

A. 273.

(250)

[illegible]

ACACIA
Senegal.

Gum Ghati.

INDIAN TRUE
GUM ARABIC.Indian
Method of
Collection.Difficulties
of Trade.Bombay
Gums.Indian True
Gum Arabic.Beluchistan
Supply.

Two Kinds.

must denote the extent of admixture rather than the nature of specific variations. Gum when detected is gathered casually by women and children or by the shepherds and is sold in small quantity to the nearest shopkeeper. It is then conveyed to the next larger dealers and so on through many hands until the produce of a wide area and a multitude of diverse gums get hopelessly intermixed. Nowhere in India is gum systematically produced and indeed hardly anywhere in this country could it be said that arborescent vegetation was so exclusively of one gum-yielding tree as to admit of a large uniform and constant supply being organised in any particular gum.

Mr. J. G. Prebble (in the paper to which reference has already been made) describes 27 gums as met with by him in Bombay. These include *Acacia arabica*, *A. Catechu*, *A. Farnesiana*, *A. leucophlœa* and *A. modesta*. To that list must be added two and perhaps the most important of all, *viz.*, *A. Jacquemontii* and *A. Senegal*. The reader should consult the remarks already made for the specific peculiarities of these gums. The present observations are intended to deal with them collectively as constituting the superior qualities of *INDIAN GUM ARABIC*. *A. Jacquemontii* reaches Bombay as one of the "Amritsar gums" and is also very largely exported from Karachi as "Sind gum." *A. Senegal*, though it has not as yet received separate recognition by Indian merchants, is a gum of great merit and one which might fairly well be removed from its present obscurity and treated as *INDIAN TRUE GUM ARABIC*. The chief supply comes from Sind, but as the plant is fairly common in Rajputana it is also no doubt obtained from that region in mixture with the gums of other Acacias.

Some short time ago Captain M. A. Tighe, I.S.C., Political Agent, Southern Beluchistan, was induced to give attention to this subject. He ultimately furnished me with admirable samples of the gums and with corresponding botanical specimens of the plants from which these gums had been procured. The two gums in question were thus definitely determined as follows:—*khôr* (or *khôr-ka-khôr*), *Acacia Senegal* and *harbarbara*, *A. Jacquemontii*. The following passages from Captain Tighe's report will, therefore, be read with much interest:—

"I found that gum was exported from Las Bela to Karachi and that among the Hindu traders two qualities were recognised, the TRUE and the SPURIOUS."

"The former (vernacular—*sacha khôr*) is the product of a tree that I have ascertained to be *Acacia Senegal* and known as *khôr* in Las Bela and Sind. The latter or spurious gum (*khôri khôr*) is presumably the product of the common *babul* or *kikar*, *A. arabica*, and another species of *babul* locally known as *harbarbara* or *Acacia Jacquemontii*."

Sind Gum.	(G. Watt.)	ACACIA Senegal.
“Dr. George Watt has pointed out that Gum Arabic is a natural product of India, but that it has failed to find a good market owing to the mixing of all kinds of gum in India. Now in the levy tracts of the Sind Bela border it would be a simple matter to prevent this adulteration, as, from my observations, I think it would be easy to control the collection. In the Khudho hills, I did not see any other Gum-bearing trees with which the true <i>Acacia</i> could be confounded. Lower down towards Karachi, in the Chutta country, the <i>harbarbara</i> becomes apparent in the beds of the water courses, but the true <i>Acacia</i> was just as frequent on the hill sides.”		INDIAN TRUE GUM ARABIC.
“The hills were plentifully covered with the latter. I do not mean to say the hills were clothed with vegetation, as they look bare at a distance of 3 or 4 miles, but on approaching them you can see a goodly show of trees, and I should say 75 per cent. or more were <i>A. Senegal</i>.”		Adulteration.
“There is no regular collection of the gum. Women and shepherds occasionally collect a little and barter it to the <i>banias</i> for anything they may want. The latter accumulate whatever is brought until they have sufficient to take to Karachi. The collection is thus made casually by <i>banias</i>, who sell it to the leading Native firms in Karachi who in turn sell it to the European merchants.”		Percentage of Trees.
“I do not place much reliance on information regarding prices given me by <i>banias</i>, but according to them, they get at ₹13 a maund. I heard they were getting ₹16 and 18 per maund for the first sort, ₹10 and 12 for the second sort.”		Method of Collection.
In a later communication Captain Tighe writes :—“The Bela officials do not seem to have taken a very lively interest in the matter. In obtaining the samples they have depended chiefly on the <i>banias</i>, while it may be supposed they are not likely to regard favourably the exploiting by the Sirkar of a field that, as far as it goes, brings them in a considerable amount of profit for a minimum outlay.” “I must add, however, that at this particular moment the various trees are almost entirely destitute of gum. This is owing, I believe, to the scanty rainfall of the past season. Had the monsoon rains been more plentiful, the period after their cessation, <i>viz.</i>, October onwards, would have been the time for the gum to appear. Unfortunately even the winter rains have failed and I fear that some still further delay must occur before the required specimens can be furnished.”		Price.
Captain Tighe’s description of the country, of the season of flow of gum, and its dependence on rain, will recall the conditions that prevail in the regions where the <i>TRUE GUM ARABIC</i> is produced. I may add, in conclusion, that in Karachi the merchants were found by me to be far too indifferent to the desirability of encouraging and developing a trade in the true gum as compared with the spurious. The fact that there were two widely different qualities was fully recognised, but the prices offered for the one as compared with the other, could hardly be regarded as calculated to encourage their		Influence of Rainfall.

ACACIA
Senegal.

Trade Returns.

INDIAN TRUE
GUM ARABIC.South Indian
Trade.TRADE IN
INDIAN GUM
ARABIC.Re-Export
Trade.

being kept distinct. Curiously enough far to the South at Tuticorin, I found a modern trade in gums being encouraged on a much more healthy basis. Considerably different prices were paid for the various grades and at least one firm employed a staff of persons to hand-pick and assort the gums they had purchased. I was unable to ascertain the species of plants that afforded these South Indian gums, but one or two at least must have been *Acacias* and very possibly were *A. ferruginea*, *Latronum*, *leucophlœa*, *Suma* and *Sundra*. Perhaps of these the most important would be the last mentioned which is the South Indian variety of *A. Catechu* and is an abundant tree from Coimbatore, northwards to the Deccan and Guzerat. It is known to yield gum freely and of a very good quality.

Trade Return of Gum.—During the past six years the exports of *INDIAN GUM ARABIC* to foreign countries have thus fluctuated; in 1895-96, 32,236 cwt. value ₹7,72,642; in 1896-97, 58,769 cwt. value ₹13,79,693; in 1897-98, 46,525, value ₹9,06,178; in 1898-99, 41,469 cwts., value ₹7,14,632; in 1899-1900 46,254, value ₹7,70,947; and in 1900-1901, 37,553 cwts. value ₹6,99,883. There has consequently been a decrease in value. These exports may be analysed thus, in 1900-1901, 37,045 cwt. were sent from Bombay, 371 cwt. from Karachi, and 133 cwt. from Madras ports, with 4 cwt. from Bengal. The trade thus centres mainly in Bombay. The following facts may now be given of the foreign gums imported into India, and again re-exported as *EAST INDIAN GUM ARABIC*:—The imports from Aden, African, and Red Sea ports in 1895-96 were 5,627 cwt. value ₹1,04,838 and in 1900-1901, 2,355 cwt. value ₹49,879. There has thus been a decline in the imports of foreign gums by sea. But during the same period 11,400 cwt. value ₹1,72,991 and in 1900-1901, 12,171 cwt. value ₹1,61,355 were re-exported, and the difference between the imports of foreign gums and the re-exports must represent (1) the foreign gums brought to India across the land frontier; (2) the varying extent to which stocks on hand are spasmodically drawn upon; or (3) the adulteration with *INDIAN GUM ARABIC*. But the re-export trade fluctuates very greatly, thus from the figure given above for 1895-96, it fell to 7,391 cwt. in 1896-97, to 5,951 cwt. in 1897-98; then rose to 7,297 cwt. in 1898-99, and to 16,781 cwt. in 1899-1900; falling again to 12,171 in 1900-1901. If any reliance can be put on the declared valuations of these gums, it may be pointed out that the imported gum is the highest priced; that the *INDIAN GUM ARABIC* is next most expensive; and that the re-exported or *EAST INDIAN GUM ARABIC* is the least expensive of the three qualities shown in trade returns.

The figures here discussed are those given for Gum Arabic not the "Other Gums" and "Resins" which are recorded as imported and exported to and from India.

Geographical Distribution.

(G. Watt.)

ACACIA
Catechu.

VARIETIES.

ACACIA CATECHU, Willd.; (*Dict. Econ. Prod. I.*, 27-44); Prain, *Some Additional Leguminosæ* (*Journ. Asiatic Soc. Beng.*, Vol. LXVI, Pl. II., 1897, pages 508-9).

The *CUTCH* or *CATECHU* tree throughout India is known as the *khair* or *katha*. Rice draws attention to the fact that the *khadira* tree is in the Vedas used as a simile for strength. In the paper above cited Major D. Prain, M.A., M.B., LL.D., I.M.S., has rendered valuable service by establishing the characteristics and respective areas of distribution, of the three forms of this plant. He regards these as but varieties of one species; whereas Roxburgh treated them as separate species. Major Prain's opinions and conclusions may be briefly set forth as follows:—

(α) **A. CATECHU**, Willd. (*proper*). *Calyx petals and rachis with spreading hairs*.—This is the most Northern form having been recorded as met with in Hazara, Kashmir, Simla, Kangra, Garhwal, Mussoorie, Central India, Behar and South to Ganjam. But it has never been found in the Eastern Himalaya nor in Assam, and it has been only once reported as met with in Burma, *viz.*, at Pegu where, according to Kurz, it is called *sha*. This is, therefore, the *kath*-yielding form of Kumaon—the *PALE CUTCH* as it is sometimes called.

PALE
CATECHU.
Botanical
varieties.

(β) **A. CATECHUOIDES**, Benth.—*This may be recognised as having the calyx and petals glabrous but the rachis puberulous*. It is met with in Bengal from Monghir and Patna to Sikkim, Assam and Burma. Though quite common in Pegu and Prome this has not as yet been collected in the Shan Hills nor in Upper Burma to the North of Ava. This is, therefore, the *cutch*-yielding form of Burma—and “*PEGU CUTCH*” is the chief commercial form of the extract.

PEGU CUTCH.

(γ) **A. SUNDRA**, DC.—Major Prain *distinguishes this variety by the circumstance that the calyx, petals and rachis are all glabrous*. It is the Southern and Western plant and affords the *cutch* of Madras and Bombay Presidencies. Is very common from Coimbatore Northwards to the Deccan, Kanara and the Konkan and has been recorded so far to the North-West as at Kathiawar and in Rajputana also to the North-East in Burma, at Segain, Mandalay and the Shan Hills. It is the *lál-khair* (*RED CATECHU*), the *nalla-sandra* (or simply *sandr*, or as Sir Walter Elliot renders it *chandra*), the *kati*, *kute*, *kachu*, *kempu*, *shemi*, *karungalli*, *baga*, *banni*, etc.

MADRAS AND
BOMBAY
CUTCH.

These three forms are said to be practically identical in their properties and uses. They certainly all yield a GUM, an astringent EXTRACT and a useful TIMBER. How far this general statement can however be regarded as correct will be seen from the remarks that follow, in which it will be noted a contention is put forth that the extracts at least differ from each other.

Properties
and Uses.

A. 135.

ACACIA
Catechu.

History of the Extract.

CUTCH.

1.—GUM.

This is of a pale yellow colour and often occurs in tears one inch in diameter. It is sweet to the taste, is soluble in water, forms a strong pale-coloured mucilage and is not precipitated by neutral acetate of lead, but gelatinises with basic acetate of lead, ferric chloride and borax. It freely reduces Fehling's solution. It is a better substitute for the *TRUE GUM ARABIC* than is *babul* gum. And, as already stated, much of the superior qualities of *INDIAN GUM ARABIC* are very possibly obtained from this species (more especially variety *Sundra*) and the modern exports from the Malabar Coast, such as from Tuticorin, are in all probability mainly derived from that plant.

TIMBER.

2.—THE TIMBER.

Sapwood yellowish white, heartwood either dark or light red, extremely hard. It seasons well, takes a fine polish and is extremely durable. It is used for all kinds of agricultural implements, bows, spears, sword-handles and wheel-wright work. It is in Burma employed for house posts and very largely as fuel for the steamers of the Irrawaddy Flotilla. The FUEL of dead *khair* is much valued by goldsmiths. In Northern India cutch wood is made into CHARCOAL and is regarded as one of the best woods for that purpose. It has been pronounced good for railway sleepers. A cubic foot weighs 70 lbs. But it is as the material from which CATCH extract is prepared that the wood of this plant attains its greatest value.

Fuel.

Charcoal.

CUTCH.

3.—THE EXTRACT CUTCH OR CATECHU.

It is not proposed to deal with this substance very elaborately in the present review. The article in the *Dictionary of Economic Products* amplified as it has been by *The Agricultural Ledger No. 1 of 1895, No. 2 of 1896 and No. 35 of 1896*, contains practically all that is known. The reader is referred to these publications and the remarks that follow must, therefore, be accepted as a mere abstract intended more especially to represent the aspects of commercial interest :—

COMMERCIAL
FORMS.

History.—Although the wood of *A. Sundra* affords *CATECHU* or *CUTCH*, it is much less frequently used for that purpose than either of the other two forms of the species. It is in all probability the plant that affords the cutch of Dharwar, of the South Konkan, of Khandesh, of Surat and of Baroda. The cutch of Pegu is derived from *A. Catechuoides* and the *kath* of Kumaon, the cutch of Dehra Dun, Gonda and Chutia Nagpur from *A. Catechu*. It remains to be seen how far the peculiarities of these trees account for the different properties of the extracts. Hitherto the possibility of these being dependent on the species (or variety) of plant, has escaped attention. But it may be mentioned as a curious circumstance, very possibly connected with *A. Sundra*, viz., that one of the earliest European writers, Barbosa

Various Forms.	(G. Watt.)	ACACIA Catechu.
(1516 A.D.), speaks of <i>cacho</i> as exported from Cambay to Malacca. The name <i>cacho</i> would seem to be simply the Kanarese <i>kachu</i> and very possibly gave origin to the modern Latin name <i>Catechu</i>. In 1574 Garcia de Orta gave a complete account of the plant and of the manufacture of the extract, under its Tamil name of <i>kati</i> (<i>cate</i>) a word which by some authors gave the first half of the name <i>Catechu</i>, the second being derived from <i>chuana</i>, to distill. Although the earliest European authors saw the extract being prepared from <i>A. Sundra</i>, it is probable that the manufacture in Pegu is quite as ancient, if not more so. But it was not until the 17th century that <i>Catechu</i> attracted the attention of Europe. It was then supposed to be a natural earth and as it reached Europe by way of Japan it received the name of <i>TERRA JAPONICA</i>. About the same time <i>GAMBIER</i> also found its way to Europe and was indiscriminately with <i>Catechu</i> designated <i>TERRA JAPONICA</i>. Cleger exploded the mineral notion of these substances by republishing in 1685 Garcia de Orta's account of the preparation of the extract. He affirmed that the best quality came from Pegu, other sorts from Surat, Malabar, Bengal and Ceylon.		DARK CATECHU.
		Exported from Cambay.
		Origin of Name.
		Terra Japonica. Gambier: First Mention of Pegu Cutch.
Forms of Catechu.—There are said to be three forms of this substance (1) <i>DARK CATECHU</i> or <i>CUTCH</i>, chiefly used for industrial purposes : (2) Indian <i>PALE CATECHU</i> or <i>KATH</i>—a crystalline substance eaten in <i>pán</i> or used medicinally : and (3) <i>KEERSAL</i> (<i>KIRSAL</i>), a crystalline substance found imbedded in the wood, much after the same fashion as <i>BARUS CAMPHOR</i>.		Forms of Cutch.
The following particulars may be given regarding the manufacture of the two first mentioned extracts :—		
1. Dark Catechu or Pegu Cutch.—Three men generally work together : one cuts down the trees and drives the cattle that drag these to the site of the furnace : the second clears off the sap wood and cuts the heart-wood up into the little chips required by the third man who attends to the furnaces and boilers. The chips are packed into three to four gallon earthen pots which are then filled up with water, and the whole boiled for 12 hours. When the water is boiled down to one-half the chips are taken out, and the liquid of 20 to 25 pots is gradually poured into a large iron pan or cauldron, and again boiled and stirred and fresh added from the earthen pots until the fluid attains the consistency of syrup. The cauldron is then taken off the fire and the contents stirred continuously with a wooden paddle for four hours or more till the mass cools and can be handled. It is then taken out and spread on leaves arranged within a wooden frame like a brick mould. It is left over night and in the morning is dry and ready to be cut up into pieces for the market. It might then be described as a brick of cutch weighing 36 to 44 lbs.		DARK CATECHU OR PEGU CUTCH. Three Men work together. Chips boiled in Earthen Pots. Iron Cauldrons. Stirring. Wooden Mould.

ACACIA
Catechu.

Manufacture of Cutch.

CUTCH.	The chips are sometimes boiled down a second time, but as a rule very little is extracted by this farther boiling. Much difference of opinion prevails as to the necessity of beating the liquid after the cauldron is taken off the fire. Some manufacturers are satisfied with half-an-hour, others give it as much as four or five hours.
After Treatment.	
Season of Working.	Cutch manufacture takes place from the 1st June to 31st March, but the months of December to March inclusive are those of most energetic operations. The produce of each cauldron is approximately as stated 36 to 44 lbs. a day, but the total yield during the season cannot be accurately determined since much depends on the quality of the trees, their proximity to the boiling place and above all the working days of the season. The proceeds of one cauldron may be 2,000 lbs. or it may exceed 6,000 lbs. As to yield of cutch to weight of heartwood, it is believed that a ton of wood might be taken as yielding 250 to 300 lbs. of cutch.
Yield.	
Other Forms of Cutch.	On the Western side of India as at Kanara, Dharwar, Khandesh, Surat and Baroda and to some extent in Chutia Nagpur in Bengal, in Dehra Dun and at Gonda in Oudh, dark coloured cutch is also prepared by a process that only differs in minor details from that briefly described in connection with Pegu. The industry in these regions is on a much smaller scale, and the appliances correspondingly less perfect, but the principle involved is the same. In Guzerat, as a rule, the trees are not felled, but the larger branches are simply lopped off, and these are cut up and boiled down into cutch. The article as met with in the market, from these localities, differs, however, materially in external appearance and shape from <i>PEGU CUTCH</i>. It occurs in small cubes, flat cakes or rounded balls, and is of a redder colour and more opaque fracture and less shining; but, as already hinted, how far the chemical property and industrial value is influenced by the circumstance that the trees employed are botanically different varieties, remains to be investigated in the future. As already explained the plant used for <i>PEGU CUTCH</i> is <i>var. Catechuoides</i>: for Western and Southern Cutch, <i>var. Sundra</i>: and for Northern cutch, <i>var. Catechu</i>. The influence of the method of manufacture more especially the use of iron cauldrons will be discussed in a further paragraph.
PALE CATECHU.	2. <i>Pale Catechu or Kath</i>.—This is the restricted name, given in Northern India, to a grey crystalline substance prepared from a concentrated decoction of the wood of <i>var. Catechu</i> by placing in it a few twigs and allowing the decoction to cool. The twigs are removed and the crystalline substance found adhering to them is collected, and pressed into large irregular cubes. Whether the liquid is rejected or is afterwards boiled down to produce a poor quality of dark catechu or cutch has curiously enough not been recorded.
Method of preparation.	

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Manufacture of Kath.

(G. Watt.)

ACACIA
Catechu.

The cubes of grey crystalline substance is the *kath* which is eaten by the Natives in their *pán* and which imparts with lime a red colour to the lips. It is apparently hardly ever exported to Europe and the name *kath*, while chiefly applied to it, is in some parts of India unfortunately also given to cutch. *Kath* and Cutch have by Europeans been mistaken for the same substance, but the former is much purer chemically than the latter, and it may be owing to the fact of cutch being the form exported to Europe, that catechu has lost the former position it held as an astringent MEDICINE. It seems probable that the preparation of *kath* may be a secondary process from the cutch, since its direct preparation from the original decoction has only been observed at Kumaon, although the substance is universally used in *pán* all over India. This subject deserves to be thoroughly investigated, and the merits of *kath* and its process of preparation made known. In a further paragraph will be found an abstract of recent investigations that have a bearing on the issue here raised.

KUMAON
KATH.Medicinal
Form.
Secondary
Manufacture.

The dark and the pale forms of *khadira* were both well known to the Sanskrit writers, but in later times they seem to have been confused with each other. The process of preparation of *katha* or *kath* was described by Madden and no more recent observer appears to have watched the manufacture with the same interest. "One portion of the *khairis*, wrote Madden, is constantly employed in cutting down the best trees, and for these they have to search far in the jungles; only those with an abundance of red heartwood will answer. This is chopped into slices a few inches square. Under two large sheds are the furnaces—shallow, and with a slight convex clay roof pierced for twenty ordinary-sized earthen pots. This operation takes place in about an hour and half. The liquor resembles thin light port, and the *katha* crystallizes on leaves and twigs thrown into it for that purpose. Each pot yields about a seer of an ashy white colour. The work is carried on for twenty out of the twenty-four hours by relays of women and children; the men merely preparing the wood, which, after being exhausted, is made use of as fuel."

Madden's
Account.

3. *Keersal* or *Khersal*.—From the wood of *Acacia Catechu* is occasionally obtained a pale crystalline substance known as *khersal*. The woodmen, when cutting up the timber for fuel, sometimes come across this substance and carefully collect it, since it is much valued as a medicine by the Hindus, and fetches a high price. Dr. Dymock (*Mat. Med., Western Ind., 232*) says of it:—

KHERSAL.

"*Keersal* or catechuic acid is obtained from cavities in the wood and occurs in small irregular fragments like little bits of very pale catechu mixed with chips of reddish wood." "In the forests near Bariya, Guzerat, this substance is collected and is regarded as a valuable cure for coughs." (*Bom. Gaz., VI., 13*). It appears to be

A. 135.

ACACIA Catechu.		Recent Investigations.
CUTCH.		procured from any of the three varieties of <i>A. Catechu</i> though in the passages just quoted the reference is of course to <i>var. Sundra</i> .
Dr. Warth's Investigations.		<i>Recent Investigation.</i> — <i>The Agricultural Ledger</i> (No. 1 of 1895) records Dr. Warth's experiments and results in the manufacture of cutch and the correspondence that ensued on his recommendation for the establishment of central factories under Government control. Dr. Warth showed that the Native system was wasteful and destructive, more especially through the use of iron cauldrons. He explained that the active principle of cutch was the tannin known as <i>Catechu-tannin</i> . This forms a greenish-brown compound with ferric salts. There is also present, however, another substance known as <i>Catechin</i> and this is the active principle in <i>kath</i> or the edible form of cutch. Catechin is, however, easily changed into tannin. It is soluble in hot water but practically insoluble in cold water, while Catechu-tannin is completely soluble in cold water. By this simple circumstance Warth proposed that catechin should be invariably separated from the Catechu-tannin and sold by itself, but he showed that it was essential that this should be accomplished by a rapid process and in concentrated solutions. Etti had previously pointed out these peculiarities but Warth gave them a practical value. The concentrated decoction is by him recommended to be set aside for five days, to allow of the formation of the crystalline Catechin. Cold water is then added and the solution filtered and the filtrate again boiled down to form Cutch free from Catechin. It seems probable that by some such process <i>kath</i> may be regularly manufactured by the drug-dealers of India, since the Kumaon supply could hardly suffice to meet the Indian consumption.
Catechu-tannin and Catechin.		
Separation of.		
Recent investigations.		
Preparation of Kath.		
Wood Spotted White.		Warth then demonstrated the injurious action of iron on Catechin and urged that copper cauldrons should be invariably used. Warth's observation that wood spotted with white deposits is richest in a Catechin and that such wood is more prevalent in Oudh than in Burma, confirms a wide-spread Native opinion and probably points to something peculiar in the variety of plant grown in Oudh as compared with that of Burma.
Dr. Leather's Researches.		The inquiry was next prosecuted by Dr. Leather, Agricultural Chemist to the Government of India. His Assistant, Mr. Collins, furnished a most instructive table of analyses in which he showed that commercial valuations rarely coincided with percentage of Catechu-tannin and Catechin (more especially of the latter) but was dependent mainly upon the appearance of the extract. So far as the tanner is concerned the complete absence of Catechin might be said to be a recommendation. Dr. Leather dealt in a most interesting manner with the best methods of cutting up the timber, with the
Commercial Valuation		
Important Considerations.		

**ACACIA
Catechu.***Trade in Cutch.*

**TRADE IN
CUTCH.**
Fluctuations.

ignores local consumption. Thus, for example, the total exports to foreign countries were 183,729 cwt. valued at Rs 36,96,106 in 1895-96; 122,082 cwt. in 1896-97; 97,187 cwt. in 1897-98; 61,669 cwt. in 1898-99; but it rose again to 127,815 cwt. valued at Rs 24,70,422 in 1899-1900, and in 1900-1901 fell to 101,995 cwt., valued at Rs 18,91,369. Of course the bulk of these transactions are from Burma. For example, taking the last-mentioned total exports, Burma furnished 99,729 cwt., Bengal 2,202 cwt., Madras 57 cwt., and Bombay with Sind, 7 cwt. The Bengal trade seems for some years to have declined and direct shipments from Burma to have increased. The United Kingdom, the United States, the Straits Settlements and Egypt are the countries to which the largest consignments are made. The United Kingdom takes from 70 to 80 per cent. of the total annual supply. Of the coastwise traffic Bengal (Calcutta) is the most important receiving centre and Burma the most important exporting. In 1895-96, Bengal received 35,079 cwt., but that traffic seems to have declined seriously and last year was less than half the quantity named. The Rail, Road and River borne trade shows Bengal Province as the most important receiving centre and mainly from the town of Calcutta. While the North-Western Provinces might be called the most important exporting centre, the major portion going to Bombay town and presidency.

Coastwise.

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AGRICULTURAL LEDGER.

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AGENTS.

IN BRITAIN.

Messrs.—

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ON THE CONTINENT.

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ACONITUM spp.

[*Dictionary of Economic Products, Vol. I., A. 396.*]

THE INDIAN ACONITES :
THEIR VARIETIES, THEIR DISTRIBUTION AND THEIR USES.
By GEORGE WATT, M.B., C.M., F.L.S., C.I.E.

ACONITUM is a genus of perennial herbs which belongs to the Natural Order **RANUNCULACEÆ**. It comprises in the whole world about 180 species, chiefly inhabitants of the Northern temperate zones. In India seven or eight species are met with, but a few of these possess several very striking and locally important varieties some of which might with advantage (from the economic standpoint at least) be regarded as distinct species.

The Indian area of distribution may be described as extending from Afghanistan, Baluchistan, Hazara, Kashmir, Kumaon, Nepal, Sikkim, and Bhutan to the mountains of Assam, Manipur, and Burma. But on the mountains of Central, Western and Southern India no representative of the genus occurs.

While these interesting plants are thus confined to the lofty mountainous tracts that skirt the geographical frontier of India, few drugs are more frequently present or more generally understood by the rural drug dealers—so far as such knowledge goes—than are certain forms of the genus *Aconitum*. In fact it might be said that the Aconites are very much more extensively used in Indian pharmacy than is the case at the present day in Europe and America. But perhaps the most poisonous forms are most largely employed as animal poisons—if one might not say in criminal poisoning—than in medical practice. This circumstance thus enhances the interest and value of the researches recently instituted into the subject of the

INTRODUC-
TORY.

Monk's-hood.

Distribution.

Poisoning.

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ACONITUM.

Recent Investigations.

INTRODUC-
TION.

Bazar Roots.

Trade.

Botanical
Specimens.Important
and
Unimportant
Species.Commercial
Forms.

A. LURIDUM.

Indian Aconites. It has in fact been recognised, for some years past, as an imperative necessity, *viz.*, to be able to readily and with certainty distinguish at least the chief qualities of Aconite root, as met with in the Indian bazars. It was felt that, were that possible, the further stage, *viz.*, to have these roots chemically and physiologically investigated, might be comparatively easily accomplished by the army of talented and voluntary workers in Europe whose services could readily be enlisted. It was believed that all that was necessary to develop a regular and satisfactory trade in Indian Aconite (and to be able to control and supervise such traffic if need be), was definite knowledge of the chief forms that exist and the regions from which these are severally derived.

Keeping that object in view I have conducted since 1893 certain tours of inspection to a few of the regions of supply and have thus been enabled to study the fresh plants on the spot. I have further been fortunate enough to secure the generous assistance of several Forest Officers and others whose official duties lead them to the aconite areas, or bring them into personal contact with the traders who regularly export the roots to the plains. I have at the same time called upon the Government Medical Store-keepers, and the Druggists and Merchants of India to favour me with samples of the roots in their possession and to accompany these with such information as they may possess regarding the names given to these roots, the sources from which they are procured and the purposes which they serve. Extensive collections have in consequence been secured and a special effort put forth to obtain along with each consignment of root a corresponding botanical specimen *with root attached*. It has thus been possible to arrive at a few fairly definite conclusions and to establish expectations of even better results in the future, from the investigations still in progress. Under these considerations I may be excused from giving here the most cursory sketch and in doing so pardoned for the possible misconceptions that are very likely to be established by extended research; for, in my opinion, the genus needs revision very badly, and must be carefully studied by a competent botanist. It will be very satisfactory to all who have to concern themselves with these plants, if this be accomplished early. *Aconitum ferex* (all varieties), *A. heterophyllum* and the plant or plants hitherto designated *A. Napellus* (excluding two varieties), are the forms I propose to regard as commercial and the following in alphabetical sequence are the unimportant forms.

ACONITUM LURIDUM, *Hook. f. & Thoms. (Fl. Br. Ind., I., 28)*.—This species has recently been furnished by Mr. C. Gilbert Rogers, I.F.S., Deputy Conservator of Forests, Darjeeling. He tells

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Unimportant Aconites.

(G. Watt.)

ACONITUM
Napellus.

us that it is known as *suya-banshi* and is a rare plant found on Sandakphu. "It has no fleshy root like the other species of aconite but an underground rhizome which is not thickened but is enclosed in the scaly leaf sheaths reduced to a fibrous mass."

A. LURIDUM

A. LYCOCTONUM, Linn. ; (*Fl. Br. Ind.*, I., 28).—This species occurs in Europe and Northern Asia and on the Western Himálaya from Kumaon to Kashmir between altitudes of from 7,000 to 10,000 feet. It frequents forest glades but exists there in small isolated patches. The root does not appear to be used medicinally in India. The reader will find a brief comparative statement of its chemistry in Dr. H. A. D. Jowett's most learned paper on *Atisine* published in *The Agricultural Ledger* No. 32 of 1896 (page 8).

A. LYCOC-
TONUM.

! Roots.
Chemistry.

A. NAPELLUS, Linn. ; (*Fl. Br. Ind.*, I., 29). **Var. MULTIFIDA** and **ROTUNDIFOLIA**.—The *Flora of British India* speaks of the plant hitherto supposed to be this species as embracing two poisonous varieties, besides the two above mentioned non-poisonous forms. But from a communication I have had the pleasure to receive from Sir William Thiselton Dyer, it would appear Dr. Stapf has come to the opinion that *A. Napellus* proper does not exist in India at all. I have long felt that a mistake had been made in the association of so many forms under one species. From an economic point of view at all events the non-poisonous forms have to be regarded as very distinct and as necessarily forming a group by themselves for, in addition to the circumstance of being non-poisonous, they are never collected for the purpose of export. They are said to be eaten by the shepherds on the alpine ranges, but I have failed to find that they bear any regularly recognised vernacular names. These non-poisonous forms, moreover, occupy a very definite and restricted area. They occur plentifully from Garhwal to Kashmir, but rarely, if ever, in association with the poisonous forms. The great centre of development of the poisonous forms might be said to be north and west of Kashmir, viz., in Gilgit, Hazara, and Beluchistan, and it seems probable one of them occurs also in Nepal (*Conf.* with remarks below under *A. rigidum*.) Further it is significant that in structure, the roots of both these non-poisonous forms are practically identical and very much more closely resemble the roots of *atis* (*A. heterophyllum*) than of the poisonous forms of series. They are pale white farinaceous roots with, as a rule, only one circular cord of fibro-vascular tissue in which the vessels are grouped in wedge-shaped bands.

A. NAPELLUS.

Never
Exported.
Edible Roots.

Habitat.

Structure
of Roots.

A.
PALMATUM
Habitat.

A. PALMATUM, Don ; (*Fl. Br. Ind.* I., 28).—This species would seem to be distributed from Garhwal through Nepal to Sikkim

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ACONITUM
palmatum.

White-Bikhuma, Bikhma, Jadvar, Nirvishi.

A.
PALMATUM.Vernacular
Names.Aconite
Antidote.Two Forms
of Jadvar.Last Year's
Atis.

and possibly to the mountain of Assam. Mr. C. Gilbert Rogers, tells us that it is called *seto-bikhuma* by the people of Sikkim, that is the white-*bikhuma*, while the black-*bikhuma*, is a form of *A. ferox*—*bikhuma* might be translated “similar to” or “like”—*bikkh*. The root is sold all over India and is very generally recognised as being non-poisonous. It is the *Bikhma*, *bishma*, *wakhma* and *vakhma* of the drug shops of India, names that denote a resemblance to *bish*, but also the fact that it is non-poisonous. I believe it is the root most generally sold under the name of *jadvar* and is very possibly the *nir-bishi* of Indian classical pharmaceutical works. *Nir* of course means “free from,” *bish* “poison.” According to Professor Rudolph Roth, the *nirvishi* of Sanskrit (and apparently of Dr. Roxburgh also) is *Kyllinga monocephala*, *Rottb.* But it would appear probable that while *nirvishi* may mean a non-poisonous aconite, *nirvisha* may denote an antidote to aconite. The late Moodeen Sheriff was of opinion that in ordering non-poisonous aconites the only safe word to use was the Arabic name *jadvar*. But Colonel H. St. Clare Caruthers, I.M.S., (Medical Store-keeper, Madras) has furnished me with a sample of poisonous aconite, preserved in urine (*Aconitum hians*), as being the *jadvar* of the South Indian bazars.

Moodeen Sheriff describes two forms of *jadvar* (*a*) a small root which he says is easily procurable in Calcutta, and is about three-fourths of an inch to one and-a-half inches long, conical, much shrivelled, shrunken and depressed irregularly, brown externally and internally; cuts easily and smoothly being somewhat soft in texture and though distinctly bitter, generally imparts a slight sweetish taste at first. It is quite free from acrid and tingling sensations when chewed. Now I would observe that I am unable to identify any of the numerous samples of aconite in my possession with the above description. What it most resembles is the shrivelled last year's tubers of *A. heterophyllum*. If a fairly large sample of *atis* be examined, not a few of the smooth conical characteristic roots of that species will be found with a cylindrical much shrivelled and darker coloured root attached. This is last year's tuber and one sample of *bikhma* sent to me by a European chemist in Lahore consisted almost entirely of shrivelled old tubers of *atis*. Stewart tells us that in the Punjab the name *sukhi hari*, given to this aconite, implies fresh roots springing from dry ones.

Dr. Moodeen Sheriff's (*b*) form of *jadvar* is, I believe, the present root. It is often met with broken into short lengths such as he describes. At all events it has come to me from all parts of India as being *bikhma*. Professor Paul Bruhl, of the Bengal Educational Service, who has devoted much time and care to the study of the RANUNCULACEÆ, places *A. palmatum*, *Don*, as a sub-species under

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White-Bikhuma, Bikhma, Jadvar, Nirvishi. (G. Watt.)**ACONITUM
palmatum.**

A. ferox, Wall. I regret to say that I do not concur with him in that opinion. To me it is a perfectly distinct species and economically it certainly has its nearest affinities with *A. heterophyllum*, *A. multifidum* and *A. rotundifolium*, and I think the association of these plants would be botanically more correct than to place *A. palmatum*, Don, under *A. ferox*, Wall.

**A.
PALMATUM.****External
Appearance.****Structure of
the Wood.****Alkaloid.****Trade.****A.
UNCINATUM.**

As met with in trade the root is pale-brown, it invariably exists in long, mostly straight fragments, sometimes twisted together but never completely pyramidal. The fragments range from 1 to 3 inches in length and from quarter to half an inch in thickness. In structure they are almost pure white and of a starchy consistence with large, though inconspicuous, fibro-vascular bundles, forming a complete double ring, much as in *A. ferox*, Wall., var. *laciniata*. Sometimes the rings of vessels split into several isolated portions in which case the root comes to resemble that of *A. ferox*, var. *atrox*. Still it may be said that this is perhaps the most easily distinguished of all the Indian trade aconites and as it is very generally recognised as non-poisonous and as being similar in its properties with *atis*, it is often sold under that name or mixed with *atis*. It is somewhat significant (as pointed out in the *Pharmacographia Indica*) that Wasowicz should have found the alkaloid in *A. heterophyllum* identical with that yielded by a sample of the *wakhma* tubers examined by him.

Bikhma is irregularly traded in throughout India and perhaps should accordingly have been included among the commercial forms. It has not been assigned that position, however, on account of the opinion that it is probably only as an adulterant with or substitute for *atis* that it finds a place in the drug-stalls. At all events its reputed merits as *jadvar* and *nirbishi* can hardly be entertained seriously, when its ascertained chemical and physiological properties are borne in mind. And it may be added in conclusion that some authors, such as Dr. R. H. Irvine (*Mat. Med., Patna*) gives *bikhma* the scientific name of *A. heterophyllum*. U. C. Dutt says that by the Hindu writers on Materia Medica *atis* is regarded as an antidote to poison, hence its Sanskrit names of *ativisha* or *ataicha*. It will thus be observed how intimately *A. heterophyllum* is associated with *A. palmatum*. For an account of a root known as *FALSE BIKHMA*, see *Pharmacographia Indica* (appendix, pp. 114—22).

A. UNCINATUM, Linn.; (*Fl. Br. Ind. I.*, 28).—This species might be said to be said confined to Sikkim and its most characteristic feature may be said to be its twining stems and long slender roots, embraced by fibrous sheaths. It has not been furnished as used medicinally.

A. 426.

ACONITUM heterophyllum.

Atis-root — A Mild Tonic.

A. HETERO- PHYLLUM.

A. HETEROPHYLLUM, Wall. ; (*Dict. Econ. Prod. I.*, 91—4).

Although not in its alphabetical sequence (among the commercial aconites) it seems desirable to deal with this species here, so as to bring it as near as possible to *A. palmatum* and permit at the same time of the two poisonous species being dealt with alongside of each other. This is an exceedingly abundant species on the West Temperate Himálaya from Kumaon to Kashmir and Hazara, most plentiful at altitudes of from 7,000 to 9,000 feet, but occasionally (especially on the more western section of its area) ascending to 15,000 feet. It might be described as the aconite first met with on ascending the Western Himálaya; *A. Lycoctonum* next appears, then the various forms of *Aconitum ferox* or on the extreme west of the so-called *A. Napellus* (poisonous forms), at altitudes of 10,000 to 13,000 feet; and, last of all, the non-poisonous forms of that species, up to altitudes of 18,000 feet, but most abundantly at altitudes of 14,000 to 15,000 feet. I collected *A. heterophyllum* and *A. multifidum* growing side by side on the Sach pass in Chamba, at an altitude of 14,000 feet and just underneath the Sharran glaciers in Kullu I found *A. multifidum* at an altitude of 18,000 feet. Throughout the area of greatest abundance of *A. heterophyllum*, poisonous aconites may be described as comparatively speaking unknown. *A. ferox* appears in Kunawar and from there is distributed eastward to Garhwal, Kumaon, Nepal and Sikkim. From Simla north-west through Bashahr, Kullu, Chamba and Lahaul to the frontier of Kashmir proper, practically no poisonous aconite occurs, and that is precisely the commercial area of *A. heterophyllum* as it is also the region within which the non-poisonous forms of *A. multifidum* and *A. rotundifolium* occur most plentifully.

Habitat.

Altitude.

Greatest Abundance.

Vernacular Names.

A. heterophyllum is known throughout the greater part of India as *Atis*, *atvika*, *patis*, *batis* and as already remarked (under *A. palmatum*) it is in Sanskrit *Ativisha*, which might be rendered “antidote to poison.” It seems that on the Eastern section of its distribution it is sometimes called *nirbisi*, a name which is probably, by the best informed Native drug dealers, restricted to *A. palmatum*. Moodeen Sheriff says that in South India this root is designated *vilayáti-vajje-turki*, *shimai-ativadayam* and *sima-ativasa* (*vila-yáti*, *shimai* and *sima* are words that denote “foreign” and Moodeen Sheriff thinks that it would be unsafe to order *vajje-turki* with any idea of getting the true root—the prefix “foreign” must, in every instance be given. Mr. W. R. Lawrence, C.I.E., tells us that from Kashmir this root is largely exported under the names of *patis* or *narmáda*.

Trade

Alkaloid.

It is extensively exported from the North-West Himálaya to the plains of India and can be had practically in every drug shop throughout the country. The discovery that its active principle was

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Atis-root—Description.

(G. Watt.)

**ACONITUM
heterophyllum.**

present in very small quantity, entirely destroyed its European reputation and the foreign exports were in consequence suddenly brought to an end. Its reputation as an antiperiodic has, moreover, by recent investigations been entirely rejected. But that it is a mild and pleasant tonic is universally accepted by Indian medical men. It is said to be useful in chronic diarrhoea and dysentery along with other astringents.

The reader will find a valuable account of the chemistry of this root in *The Agricultural Ledger No. 32 of 1896*. Large consignments of the tuber were sent by my office to the Imperial Institute. These were in due course placed in the hands of Dr. H. A. D. Jowett, the result being his most learned report, that may be said to have completely removed the prospects of any possible future foreign trade in this drug.

Atis root, if of good quality, should break with a short starchy fracture and present a uniform milky white surface. The fresh fully grown root is about 1 to 1½ inches long and perhaps ½ inch thick at its upper extremity. In shape it is like a minute carrot, smooth and almost quite white externally, unless when fermented by bad drying when it is sometimes of a dull grey colour. Last year's tubers are shrivelled into long straight thin warted structures, that very much resemble fragments of the thinner roots of *A. palmatum* (see para. 190). In structure *atis* roots are of a uniform white farinaceous substance, with in transverse section 4 or 5 isolated, circular bundles, the vessels of which are grouped in radiating wedge-shaped bands. Several European and Native merchants and chemists, in connection with the recent inquiry, furnished me with parcels of the roots of *A. palmatum*, under the name of *atis* and others, parcels of the true *atis* largely admixed with *A. palmatum*. These facts may be taken as denoting that in Indian pharmacy they are regarded as practically identical.

A. FEROX, Wall.; (*Dict. Econ. Prod.*, I., 87—91; P. Brühl, *Annals of Royal Bot. Garden, Calcutta*, Vol. V., 109-12.—This is the **NEPAL ACONITE** or **INDIAN ACONITE** of European Commerce.

Professor P. Bruhl, B.E.S., in the paper above cited, refers this species to three sub-species, namely:—1. **MOSCHATUM**—a Kashmir plant collected by Mr. J. F. Duthie, Director, Botanical Survey, Northern India, in the Liddar and Musjid Valleys at altitudes from 12,000 to 14,000 feet. Of this I have received no specimens (in connection with the inquiry into the medicinal aconites) nor do I think it is ever likely to figure as a commercial root. But is it by chance the *mohund-guji* monk's-hood, alluded to by Mr. W. R. Lawrence, C.I.E., in his *Valley of Kashmir*, p. 76? 2. **FEROX**, proper under this Bruhl

**A. HETERO-
PHYLLUM.**Rejected
as Antiperio-
dic.

Chemistry.

Description
of Root.Structure of
Root.Identical
Use.**A. FEROX.****A. 401.**

ACONITUM
ferox.
Nepal or
A. FEROX.
 Varieties of
 Nepal
 Aconite.

distinguishes eleven varieties and two more have been brought to light recently. But the most western portion of the area of distribution of these forms appears to be in Kunawar or what might be described as the upper division of Bashahr and from there eastward they extend through Garhwal, Kumaon, Nepal, Sikkim to Bhutan and Manipur. Bruhl's last sub-species. **3. PALMATUM** is distributed from Garhwal to Nepal and Sikkim and has already been sufficiently discussed (pages 89—91).

Chief Area.

It will thus be seen that the great area of *A. ferox* is the Central and Eastern Himálaya and that a gap occurs westward (which corresponds to the area of *A. heterophyllum* and *A. multifidum* and *A. rotundifolium*) before the tract of country is reached in which Bruhl's third sub-species occurs. But within the head-quarters of *A. ferox* there is another curiously arbitrary isolation: the western half, *viz.*, Kumaon, Garhwal and Bashahr (Kunawar division) contains a well-marked group of forms that, from an economic point of view, one is tempted to say deserves to be retained by itself. That group may be said to be represented by *A. atrox*, Wall. It is true it is to some extent diffused eastward to Nepal and Sikkim, but examples are rare and nowhere plentiful, except in Kumaon, Garhwal, and Bashahr. The eastern half of the *ferox* area is, on the other hand, most abundantly occupied with *var. spicata* (probably the type of the species) and to a lesser extent by varieties *laciniata* and *crassicaulis*. The other varieties mentioned by Professor Bruhl are hardly of any economic interest, and therefore attention may be confined to the three or four forms above named. But in this connection the reader had better consult the remarks offered below under *A. rigida*.

**Divisions of
Area.**
Chief Forms.

It seems thus highly probable that the so-called **NEPAL ACONITE** of European pharmacy is *A. ferox*, Wall., *var. spicata*, but to some extent very possibly adulterated with *var. laciniata* and probably also *var. crassicaulis*. The grade of root indicated is obtained mainly from Sikkim but a distinct proportion of it comes from Nepal by way of Sikkim and a smaller amount is exported direct from Nepal into the North-Western Provinces and Bengal. It may serve a useful purpose however to now take up the forms of *A. ferox* already briefly indicated and furnish such particulars regarding them individually as may be available. In doing so it will be convenient to disregard alphabetical sequence.

Adulteration.
**TRUE NEPAL
ACONITE.**

1. VAR. SPICATUM.—This has been recorded from Garhwal, Nepal, Sikkim and Bhutan, but it seems probable the chief supply comes from Sikkim. It is in fact very possibly the true **NEPAL ACONITE** or *Bikh* of European pharmacy. It is the plant alluded to by Sir Walter Elliot as the *ati* (very)—*visha* (poisonous) of Sanskrit authors. Dutt calls it the *visha* or *vatsanabha* of Sanskrit and the

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Indian Aconite.

(G. Watt.)

ACONITUM
ferox.

mitha-bish, *sringi-bish* or *dagra* of the vernacular. In most languages of India it is simply denoted by *bish* or *bikk* (poison)—the name which it receives by the people in Nepal and Sikkim. Messrs. Kemp & Co., Ltd., of Bombay, have furnished me with a sample of this root under the names of *bachnag* and *talia*. In Tamil it is *vashanavi*.

Bikk is the most plentiful, the cheapest and most extensively used aconite in India, but perhaps its chief consumption might be said to be as a poison rather than as a drug. Medically it is mainly employed in the manufacture of preparations intended for external, not internal, use. The roots are large, thick, when FRESH, soft, flexible and pale greenish-white, but when quite DRY, they become hard and of a dark brown or black colour externally and of a brownish-red colour internally. The half dry root when cut resembles horn in consistence, but as it matures and dries it becomes hard, and has darker portions developed as imbedded irregular patches within the tissue. These patches somewhat resemble resin in cleavage. The fibro-vascular bundles are seen to form an irregular sharply pointed, star-shaped structure that encloses a small central core surrounded by a second circular ring of fibro-vascular bundles. The Medical Store-keeper, Bombay, sent me a sample of this root, that had been preserved in cow's urine. This is a very common practice, as it saves the root from becoming weevil-eaten and does not appear to injuriously affect it. It seems probable that to this circumstance is due the fact of the root being so often described as "black" and also the further fact of its instantly staining the water into which roots are soaked. The word "*kala*" (black) seems, however, to more frequently denote that the root is viewed as a deadly poison rather than its actual colour. Colonel J. Parker, M.D., I.M.S., tells me that this root as met with in Bombay is often adulterated with the tubers of *Gloriosa superba*.

The chemistry of Nepal Aconite has recently received considerable attention. It has long been known that the chief difference between the true aconite of European pharmacy and the present root, was the fact that the alkaloid present in the latter was *pseudaconitine* not *aconitine*. The reader is referred to *The Agricultural Ledger* No. 19 of 1897 and No. 3 of 1898 for particulars on this subject. The latter paper, by Professor Wyndham R. Dunstan, and Mr. Francis H. Carr, A.I.C., gives a detailed account of the properties and decomposition products, of the alkaloid *pseudaconitine*. It seems probable that physiologically there is very little difference between the two alkaloids, except that *pseudaconitine* is very much more active. The chief objection to its extended use medicinally may be said to be the difficulty to obtain a continuous supply of the root of uniform quality.

A. FEROX.

A Poison
rather than
Drug.
External
Appearance.

Structure of
Root.Preserved in
Urine.

Black Root.

Adulteration.

Chemistry.

Physiological
Action.

A. 397.

ACONITUM
ferox.

Nepal Aconite or

A. FEROX.
Substitute.Affinity to
palmatum.A New
AlkaloidA Mistake
Made.50 per cent.
of Alkaloid.Vernacular
Names.

2. VAR. LACINIATUM ALSO VAR. CRASSICAULE.—The former variety would seem to be met with occasionally in Kunawar, Garhwal and Kumaon, is possibly present also in Nepal and becomes fairly abundant in Sikkim—it is known, so far as present inquiry goes, mainly from Sikkim supply. The latter is a rare plant and so far has only been recorded as met with in Sikkim. In Kunawar a plant has been found that for the present has been placed under *var. laciniatum*, though it may be but a more acutely dissected state of *A. atrox*. Mr. G. G. Minniken, I.F.S., says it is called *kala-mohra* in allusion to its being a more deadly poison than the *mohra*—not necessarily that its roots are darker coloured. Both *laciniatum* and *crassicaule* are designated *kalo-bikkhuma* by the people of Sikkim—a name which contrasts them with *A. palmatum*. The former is certainly closely allied botanically to that species, in fact it might almost be said that it is the inclusion of *var. laciniatum* under *A. ferox* that justifies the association of *A. palmatum* with that protean plant. The wide open branched inflorescence and the character of the follicle, are points that are very similar in *var. laciniatum* and *A. palmatum*. But *var. crassicaule* I am not sure that I know for certain; it appears to me to be a form more nearly related to *A. ferox*, *var. spicatum* than to *var. laciniatum*. Economically *A. palmatum* (white-*bikkhuma*) and *A. ferox*, *var. laciniatum* (black-*bikkhuma*) are very dissimilar, for whereas the white-root is non-poisonous, the black is exceedingly poisonous. It would, in fact, seem probable that it was this root that afforded the alkaloid to which Professor Wyndham R. Dunstan refers (*Agricultural Ledger No. 19 of 1897, page 4*) as not exactly corresponding with the properties of pseudaconitine. He reverts to this same circumstance in a letter dated 26th June 1900, but up to date his final report has not come to hand. It would be interesting, should the chemical results confirm the association of this plant with *A. palmatum* rather than with *A. ferox*, *var. spicatum*. A mistake was unfortunately made in the first consignment of the roots of this form which were sent to Professor Dunstan, and in consequence fresh consignments carefully authenticated had to be supplied and re-examined. One of the samples already examined by Professor Dunstan afforded 50 per cent. of alkaloid. Should that prove to be a distinct poison from aconitine or pseudaconitine, the urgent necessity of knowing its exact physiological action becomes at once apparent, when it is recollected that this exceedingly poisonous root is possibly mixed with much of the root that finds its way into market under the name of “*NEPAL ACONITE*.”

The variety *laciniata* would appear to be the *kala-bachnag* of Moodeen Sheriff and very possibly the *kalakut* of others. The roots are, if anything, larger than those of *A. ferox*, *var. spicatum*, but so

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Black Bikhuma.

(G. Watt.)

**ACONITUM
ferox.**

similar that they can with great difficulty be distinguished. Mr. C. Gilbert Rogers, however says the professional aconite collectors of Nepal and Sikkim have no difficulty in distinguishing the one from the other. The only external character of importance that strikes one, at first sight as distinctive, is the numerous circular scars indicating fallen lateral rootlets. These apparently abound at such regular intervals as to give the root of *var. laciniatum* the appearance of possessing numerous nodes. This peculiarity, when present, is fairly characteristic. In microscopic section *var. laciniatum* seems to differ from *A. ferox var. spicatum* by the absence of the inner ring of bundles that encloses the central core. It is thus fortunate that there are some characters by which this variety can be separated from the true "*NEPAL ACONITE*" (*A. ferox* Wall., *var. spicatum*), for there would appear to be little doubt that the indiscriminate use of *var. laciniatum* (in our present state of knowledge regarding it) is much to be deprecated.

3. VAR. ATROX (A. ATROX. Wall.).—This very plentiful form is met with West of Nepal to Kunawar and may be said to be most abundant in Garhwal, where, according to Mr. J. F. Duthie, Director, Botanical Survey, Northern India, nearly every alpine valley has a form of it peculiar to itself and which bears a name dissimilar to that in the next valley. Mr. Duthie was good enough to send for my inspection the entire series of aconites in the Saharanpur Herbarium. These were gone over very carefully by Professor Bruhl and myself. We came to the conclusion that the aconites collected by Duthie in Garhwal and Kumaon, and which bear the following vernacular names, were all local forms of *A. ferox, var. atrox, viz.*:—*Phatikia, bhanwa, kawriya, diluja, dhanla, dhumuriya, jhirina, gobriya* and *gobari*. The Deputy Commissioner of Garhwal furnished (in November 1899) a parcel of this root which was forwarded to the Imperial Institute for chemical examination and report.

Speaking of Kumaon, and as illustrative of the abundance of aconite, it may be remarked that Moorcroft attributed the stupefiant effects of the honey from certain localities as due to the bees feeding on aconite. Mr. G. G. Minniken, who has given much careful study to the aconites of Kunawar, has furnished at least two forms of *var. atrox*, one of which is possibly an undescribed and distinct variety. He tells us that in his part of the country the poisonous aconites are collectively designated *mohra* and that the most abundant and the one which alone is regarded as medicinal, is *A. ferox, var. atrox*. Far away to the West (in Hazara) a very different aconite (but a poisonous one), *viz.*, *A. hians* was sent to me under the name of *mohri*. It seems probable that *mohra* is intended to denote the larger size and coarser structure

A. FEROX.External
appearance.Structure of
Root.Safed
Bachnag.Garhwal.
Vernacular
Names of the
Plant.

Kumaon.

Kunawar.

Mohra.

Mohri.

A. 397.

ACONITUM
ferox.

Mohra or White-Bikk.

A. FEROX.

of the Kunawar root when contrasted with the *mohri*—the small sharply pointed Hazara root.

Bazar Names.

It is exceedingly probable that all forms of *A. ferox*, var. *atrox* are in the drug shops of the plains of India designated white-*bikk* or *safed-bachnag*. According to Native opinion this is the most valuable, and hence most expensive form, of the Indian series of aconite roots. It was sent to me by one European chemist, under the name of "*A. Napellus. Linn.*," but it would seem that North and West of Cawnpore, this is the *bikk* of the drug shops, whereas South, East and West of Cawnpore *bikk* would be the Sikkim and Nepal root discussed above under vars. 1 and 2 above. The white-*bikk* root is easily recognised; when DRY it is brittle and white on section, has a farinaceous structure, in some respects like that of *bikkma*, but it is distinctly poisonous and must, therefore, be carefully distinguished. It is usually about two to three inches long. Is broadest at the immediate extremity and gradually and uniformly tapered to a long sharp point below. It is nearly always perfectly straight. Has few thorns or warts (*i.e.*, hardened stumps of lateral roots) and the cuticle is of a chestnut-brown colour, smooth, though at the same time irregularly contracted into exceptionally large folds.

External
Appearance.Structure of
Root.

In microscopic transverse section this is a most peculiar root, quite unlike any of the other forms of *A. ferox*. In fact so much is this the case that I strongly suspect it may in future be retained as a distinct species under its original name of *A. atrox, Wall.* It possesses well-marked fibro-vascular bundles, each of an irregular flat horse-shoe shape or sometimes even elliptical, but so arranged as to construct a broad ring around a central pith. Occasionally also a few large isolated bundles occur within the chain or ring described and still more frequently the central pith, (especially in old roots), is decomposed so as to form a large central cavern. I regret to say that up to the present date I have received no report on the chemistry of this root. There would seem, however, little danger in anticipating Professor Wyndham R. Dunstan's report (which may shortly be expected) by affirming that it will be found very different from the roots discussed above under the name of "*NEPAL ACONITE.*" It comes from a definite portion of the Himálaya and, though very variable in colour of flower and shape of leaf, its roots are so constant, in the characters detailed, that it is very readily recognised by the druggists of India, more especially of Northern India.

Chemistry.

Almora
Aconite.

4. VAR. POLYSCHIZUM.—This root came to me from Mr. I. S. C. Davis, I.C.S., Deputy Commissioner of Almora, and as it was accompanied with one or two botanical specimens, Bruhl considered the material justified its being treated as a distinct variety. He accordingly gave it the above manuscript name and placed it under

A. 397.

Kumaon Aconite.

(G. Watt.)

ACONITUM ferox.

A. ferox, Wall. To me, however, it is much more closely allied to *var. atrox*, in fact it seems probable that were that form restored to specific importance, *polysechizum* would be placed as a variety under it. The specimens bore the names of *phutkia* (or *fatkia*) and *gobaria*, in the original communication,—names that it will be seen Duthie records in connection with some of his Garhwal forms of *A. atrox*. Mr. Davis forwarded a translation of a report he had received from the Political Peshkar at Garbyang, regarding aconite. It would seem that in Garbyang aconite root is designated *miha*, but that there are two forms of the plant, (a) *fatkia* and the other (b) *gobaria*,—the former is a smaller and less poisonous plant than the latter. This is very interesting, the more so since no botanical difference could be said to be recognisable between the plants furnished. The roots are in fact much like those of *atrox*, only smaller. They have a white farinaceous structure, within which is found a single non-star-shaped ring of fibro-vascular bundles. This root has not as yet been chemically examined, and I have seen no sample in the drug shops of India that would quite correspond with it, though it would appear no doubt to be regularly exported to the plains and used as a drug.

**A. FEROX—
KUMAON
ACONITE.****Vernacular
Names.****Structure
of Root.****ACONITUM NAPELLUS**, Linn. ; (*Dict. Econ. Prod.*, I., 95-91).

This is the **MONK'S-HOOD** or **COMMON WOLF'S-BANE** of European writers. It is largely cultivated as an ornamental plant in flower gardens in Europe and America and fatal accidents are by no means infrequent through the roots being eaten in mistake for **HORSE RADISH**. Curiously enough no form of **MONK'S-HOOD** would appear to have become popular as garden plants in the temperate tracts of India although its close allies, the **COLUMBINE** and **LARKSPUR**, are exceedingly popular. Possibly this may be due to the abundance of certain species of aconite as weeds on the adjacent hills. The Indian supply of the medicinal root may be said to be derived mainly from the cultivated plant and to come very largely from Germany. It is imported into India and is the chief root prescribed for internal use.

**A.
NAPELLUS.****Fatal Acci-
dents.****Supply of
Medicinal
Root.**

As observed (page 89) the plants referred by the *Flora of British India* to varieties of this species may have to be retained as separate forms owing to the opinion having been arrived at the *A. Napellus* proper nowhere exist in India. There are several well-marked forms of Aconite that must, however, be dealt with in this place since they more closely resemble (from the economic standpoint) *A. Napellus* than any of the other Indian species. The non-poisonous forms—*A. multifidum* and *A. rotundifolium* (*Conf. with page 89*)—are so very different from the poisonous ones in structure, distribution and properties, that I have ventured to suggest

**INDIAN
SEGREGATES
OF A.
NAPELLUS
IN A WIDE
SENSE.****Non-poisonous
Forms.****A. 413.**

ACONITUM
rigidum.

Nepal and Hazara Forms.

INDIAN
SEGREGATES
OF A.
NAPELLUS
IN A WIDE
SENSE.
NEPAL
FORM.

History.

Restricted
Area.KASHMIR
AND GILGIT
FORM.

their entire separation from the series. Of the poisonous forms the following may be especially mentioned:—

A. RIGIDUM, *Reichb. (Fl. Br. Ind., I., 29)*.—This form occurs in Nepal. Some few years ago a valued contributor sent me some botanical specimens of aconite which he had had collected on the Northern mountains of Nepal. One of these proved to be *Bikk* or Nepal Aconite; another a large plant, with rigid leaves deeply and acutely dissected. Sets of these were presented by me to Mr. Holmes, Curator of the Museum, Pharmaceutical Society of Great Britain, and others were deposited in the Royal Herbarium, Calcutta, and in the Royal Herbarium, Edinburgh. Professor Bruhl obligingly examined them at my request and reported that the one was *A. ferox*, *Wall.*, *var. spicatum*, and the other, matched exactly the figure given by Wallich (*Pl. As. Rar. t. 41*) and was therefore in all probability *A. rigidum*, but whether it should be retained under *A. Napellus*, *Linn.*, or transferred to *A. ferox*, *Wall.*, (as Wallich himself seems to have thought) could not be determined without seeing the seed. Unfortunately neither my samples nor the Wallichian sheets in the Calcutta Herbarium bore seed, so that Bruhl was unable to give a definite opinion. From the observations already recorded regarding the distribution of the forms of *Aconitum* on the Himálaya, one might almost be disposed to suggest that very possibly the *A. rigidum* may prove but a form of the truly protean East Himálayan species *A. ferox* *Wall.*, in which case the area of the series of Aconites here dealt with, would be restricted very greatly and have its head-quarters in Kashmir and to the North and West (but only rarely to the East) of that State.

A. DISSECTUM, *Don*.—This so far at least as economic botany is concerned includes *A. spicatum*. One or other of these forms (if they be separately recognised) is met with plentifully in Kashmir, Gilgit, Zanskar and Baltistan. A sample of what I take to be very likely *A. spicatum* was sent to me from Hazara, by Lieutenant-Colonel H. P. P. Leigh, C.I.E., Deputy Commissioner. Mr. Duthie makes the curious observation that *A. dissectum* often fails to produce flowers. It may, therefore, be inferred that he is familiar with that plant. There are certainly many sheets in the Saharanpur Herbarium named *A. dissectum* and others *A. spicatum*, but except in the more compact or more open inflorescence, there is probably very little else by which they can be separately distinguished. *A. dissectum* is recorded as occurring in Nepal, in fact the name was first given by Don to an aconite obtained from that imperfectly known country. Here and there throughout the Himálaya (from Sikkim to Hazara), occasional mention is made of one or other of the plants of this series being found, but it may safely be said they only

A. 413.

Hazara Aconite.

(G. Watt.)

ACONITUM
hians.

assume economic importance in Kashmir and Gilgit. It is in fact significant of their unimportance (if they be admitted as existing at all) on the Eastern, Central and Western Himálaya, up to the frontier of Kashmir, that none of my numerous correspondents have either sent me authentic botanical specimens or parcels of the roots of either of these plants. In fact the investigation of these two varieties, more specially the supplies of root that might be procured from Kashmir and Gilgit and the percentage of aconitine present in that root, is the most hopeful direction of future inquiry and research, regarding the Indian Aconites.

INDIAN
SEGREGATES
OF A.
NAPELLUS
IN A WIDE
SENSE.

Future
Investiga-
tions.

HAZARA
FORM.

A. HIANS, *Reichb.*—This would seem to be the most prevalent form of the *napellus*-like series of Aconites met with in India. How far its separation from *A. dissectum* and *spicatum* can be said to be clearly established botanically (or its separation even desirable economically) is a point which may be passed over, in a review like the present, professing as it does to be mainly commercial and industrial in its scope and interest. Large supplies of the root of the plant, which Professor Bruhl recognises as being *A. hians*, have been most liberally contributed by Mr. A. V. Monro, I.F.S., and after him by Mr. H. A. Houghton, I.F.S., Deputy Conservators of Forests in Hazara. The first supply was registered in my office as No. 6803, and this was examined and reported on by Professor Wyndham R. Dunstan (see *The Agricultural Ledger No. 19 of 1897, page 5*). It was found to contain aconitine—the same active principle as found in the European aconite—though in smaller proportion, so much so that the Hazara root compared very unfavourably with the imported. This result led to further collections being made at other seasons of the year, from the belief that the initial collection may possibly have been made when the root was poor in aconitine. Subsequent collections were registered as Nos. 8926, 10239 and 14757. The report on these has not as yet come to hand, but a few chemists in Northern India have since furnished samples of this small root under the name of “THE TRUE ACONITUM NAPELLUS,” and have affirmed that it was used by them in place of the imported root. One European chemist sent it under the name *mitha zahar*, so that it would seem to be regularly employed in India, though of course to a very much smaller extent than *A. ferox*, *var. spicatum* or *var. atrox*. Curiously enough *Davies’ Trade Report* alludes to 20 seers of *mitha tilia* as annually exported from Peshawar to Kabul. Moodeen Sheriff says that he believes very small poisonous roots of aconite are met with in Northern India, but these are never seen in Madras. He alludes no doubt to the present plant. A sample was recently, however, sent to me from Madras as being *jadvar*. *A. hians* is the *mohri* of Hazara and appears to be the plant described by Stewart under the names *piun*, *mohri*, *tilia kachang*

Consumption
in India.

Vernacular
Names.

A. 413.

ACONITUM
hians.

Hazara Aconite.

**HAZARA
ACONITE.**

**External
Appearance.**

Structure of Wood.

and *dudhia*,—the last being the bazar name for the root as sold in the Panjab. It is a short root, not that unlike the European article, though smaller. The remains of the stem are nearly always found on its upper extremity. It is not more than one inch (or inch and a quarter) in length. It is of a black colour; is curved, densely coated with short sharp thorns (*i.e.*, stumps of lateral rootlets); and is terminated by a short, hard, smooth pointed beak. In structure it is found to contain well-marked fibro-vascular tissue, arranged in a single star-shaped ring, very much as in the imported *A. Napellus*, *Linn.* It is, however, somewhat difficult to obtain good microscopic sections of this root, as it appears to break up on drying.

A. 413.

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G. I. C. P. O.—No. 540 R. & A.—16-8-1902.—2,230.—C. M. W.

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ARSENIC.

(WHITE ARSENIC, ORPIMENT, REALGAR.)

[*Dictionary of Economic Products*, Vol. I., A. 1425-29.]

Other Dictionary Articles that may be consulted :

Orpiment, Vol. V. O. 242.

Realgar, Vol. VI., Pt. I., R. 61.

ARSENIC AS IT OCCURS IN INDIA :

A POPULAR ACCOUNT INCLUDING THE CHIEF COMMERCIAL FACTS
REGARDING THAT SUBSTANCE BY GEORGE WATT, M.B., C.M., F.L.S.,
C.I.E.

Arsenic is met with commercially in either of the three forms :— the Oxide commonly called White Arsenic or Arsenious Acid and the Sulphides known as Orpiment (Yellow Arsenic) and Realgar (Red Arsenic). White Arsenic although it does exist in nature is purely a manufactured article, and is obtained by the sublimation of the arsenous vapours given off in the smelting of arsenical pyrites (*mispickel*) or of the tin and copper ores. In the latter instance it is of course a bye-product. The sulphides named are, on the other hand, natural minerals though they can be and to some extent are artificially produced. These three forms of arsenic are known in India by the following vernacular names :—

Vernacular Names.—*White Arsenic* or *Arsenous Anhydride*.—*Sunka bish*, *safed sambul*, *darumuch*, Bengali; *Sumbul-khar*, *sunkhya-sunbul*, Hindustani; *Somal* or *somal-khar*, Marathi and Guzerati; *Sankhya-safed*, Punjabi; *Vellai-páshánam*, Tamil; *Tella-páshánam*, Telegu; *Phashana*, Kanarese; *Seing*, Burmese.

It is *Sin-shih*, *pihsin*, *hung-pe*, in Chinese; *Sankha-visha*, *sambala-kshúra*, *darumuch*, Sanskrit; *Shúk*, *turabul-hálik*, *samm-ul-fár*, Arabic; *Marge-mósh*, *sum-ul-far*, Persian.

THREE
FORMS
KNOWN TO
COMMERCE.

White.

A. 1425-29.

ARSENIC.

Arsenic as it occurs in India.

YELLOW.

Orpiment or Yellow Arsenic.—*Haritala* or *haritálaka*, Bengali also Sanskrit; *Hartál*, Hindustani, Hindi, Marathi, Panjabi, etc.; *Aridárum*, Tamil; *Hsae-dan*, Burmese; *Tsze-hwang* or *pun-tsaon*, Chinese; *Ursaníkum*, Arabic; *Zirneik zird*, Persian.

But there are two qualities of Orpiment, (a) the one used as a medicine, (being regarded as an alterative and febrifuge) or criminally as a poison, and (b) the other for numerous industrial purposes. The former is met with in smooth shining golden scales and is known in Bengali as *Vansapatri-haritála*; in Hindustani as *Tanki hartal*; in Panjabi as *Tanki hartál* or *hartál warki*; in Marathi as *Vurki hartal*; in Tamil as *Ponaridáram*; and in Sanskrit as *Swarna haritalam*. The latter form occurs in opaque masses and is a coarser, more impure, and therefore, less poisonous article than the golden flake form. It is known in Bengali as *Pinda haritala* and in Hindustani as *Hartal pili*. The leafy or flaky orpiment appears to be chiefly imported and seems to reach Bombay mainly from the Persian Gulf port. It is this form no doubt that has sometimes been spoken of as exported from Bombay to Europe where it is used as a pigment.

RED
ARSENIC.

Realgar or Red Arsenic.—This is best known by its Hindustani name *Mansil* or *manchal*; or its Sanskrit equivalent *Manahsila*. It is also spoken of throughout the greater part of India as *Lal* (red) *sambul* (arsenic) and in Madras as *Kudiraypal-pashanum*.

HOW AND
WHENCE
OBTAINED.

Indian production and sources of supply.—There are three

localities within India, or on its immediate frontier, where the sulphides of arsenic are not only known to exist but are in sufficient abundance to be regularly drawn upon as sources of supply. These are Munsiri in Kumaon, Chitral in the Panjab and various localities in Upper Burma and Unan.

The orpiment from Munsiri is brought for sale by the Bhutias to the Bagesar fair. This is the least important of the Indian supplies. Elphinstone in his *Account of Kabul* (pages 146-47) discusses the sources of supply from across the Northern Frontier of India. He speaks of it as coming mainly from Bulkh. It has long been known that yellow orpiment is regularly brought to Peshawar for sale and it has commonly been spoken of as coming from the Swat country and Kashgar. In Kandahar it is also reported to be sold in fairly large quantities and to come from Herat. Recently, however, a writer in the *Pioneer* (September 9th, 1898) furnished a most interesting account of the Orpiment Mines of Chitral, which, he says, “are situated in a flank of the great giant Tirich-Mir.” It would thus appear probable that the Panjab may have derived its orpiment in the past as at the present day, very largely from these Chitral Mines.

Punjab.

A. 1425-29.

Arsenic as it occurs in India.

(G. Watt.)

ARSENIC.

HOW AND
WHENCE
OBTAINED.

Burma.

China.

Trade.

USES.

From the very earliest times Burma and China have been sources of supply to India, of orpiment, realgar and even white arsenic. Marsden, *History of Sumatra* (page 137) for example speaks of white arsenic as being conveyed from China and Sumatra to India in the 18th century. Mention is made of the traffic in orpiment in the *Oriental Repertory*, Vol. I., page 228, and still more recently in *Hanbury's Scientific Papers*, pages 220-1.

The white form came no doubt from remote tracts of China and at the present is mainly, if not entirely, imported by sea from these self-same localities, instead of by the old land routes. But the traffic in orpiment and realgar, from Western China through Upper Burma, is a flourishing one even now. The transactions will be found recorded in the *Trade by Land of British India with Foreign Countries*, under the heading of "*Paints and Colours*." These imports, during the past three years, have averaged 5,700 cwts., valued at ₹1,18,190 and last year shows a considerable expansion on the previous year. The foreign imports, of what appears to be white arsenic, will be found recorded under "*Chemicals*." These in 1900-1901 came to 2,766 cwts., valued at ₹56,390 and were derived mainly from Germany, the United Kingdom, Hongkong, and the Straits Settlements, but under the headings of "*Paints, Colours and Painter's materials*" it will be seen the foreign imports were valued at ₹40,39,848. What proportion of these foreign imports of pigments (if any) represent arsenic, it is impossible to determine, but the consumption of white arsenic, orpiment and realgar in the industries of India must be very extensive.

Industrial Uses of Arsenic.—White arsenic is the medicinal form in most general use. It is also largely employed in poisoning the hides and skins that are exported from India and, being more readily soluble and at the same time devoid of colour, it is the chief form used nefariously. Orpiment is not only a pigment and a dye, but it is an essential ingredient in the manufacture of shellac; it is the yellow colour in nearly all the lac toys that are made; it is the yellow of the Afridi Wax-cloths; it is the poison used in the production of insect-proof paper; it is the chief ingredient in most scrub destroyers and insecticide powders; it is used throughout India in the preparation of fireworks in order to give a blue flame; and it is an ingredient in nearly all the known depilatory ointments. Lastly, much interest has recently been taken in the subject of orpiment as a poison for locusts. It appears that a soluble preparation made by boiling orpiment (or better still white arsenic) in an alkali such as soda or potash, or even in wood ashes, may be used so very dilute that it is quite harmless to the higher forms of life but very fatal to

A. 1425-29.

ARSENIC.

Arsenic as it occurs in India.

LOCUST DE-STROYER.

locusts. This is sweetened with sugar and then sprinkled on fragments of Sorghum straw or other such substances. The poisoned straw is then strewn over the fields invaded by the insects or along the road-sides. The locusts attracted by the sugar eat the straw and die and are eaten by other locusts that also die and in turn are eaten, so that a comparatively small amount of poison soon exterminates the locusts.

Realgar is chiefly used as a pigment and in pyrotechny, being resorted to, it is said, for the purpose of producing white fires. Some few years ago the late Mr. Nicholl sent to the Indian Museum for determination a large sample of realgar which he had procured in the Amritsar bazar. On being asked for particulars he said it had been imported from Germany *via* Calcutta and was being used in the preparation of fireworks.

Medico-Legal Aspects.

Medicinal and Criminal Uses.—It will thus be seen that in some form or other arsenic is very extensively employed in India, and that it is both brought to this country across the land frontier as well as by sea from foreign countries. Mr. J. E. O'Connor shows in his returns of Medico-Legal Investigations that it is the most prevalently resorted to of all poisons, for criminal purposes. During the year 1899 out of a total of 915 cases actually investigated, where human life had been taken by means of poison, in 382 the poison was found to be arsenic. During the same period out of a total of 593 ascertained cases of cattle poisoning, 430 were by means of arsenic. Curiously enough, poisoning, and more especially arsenical poisoning, is much more frequent in the Panjab than in any of the other provinces of India. For example out of the total given above (of human life poisoning in 1899), 204 were in the Panjab, 48 in Bengal, 46 in Bombay, 42 in the United Provinces of Agra and Oudh, 32 in Madras, and 10 in Burma. It would thus almost appear as if the prevalence of arsenical poisoning in the Panjab were a direct expression of greater abundance of and more facilities in procuring the poison than prevail in other provinces. It is at all events worthy of suggestion that more careful enquiry should be instituted than appears to have been the case as to the supplies obtained by the Panjab from Chitral and the trans-frontier sources indicated above.

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ALKALIS.

(EARTHS, ASHES, ALKALOIDS, ETC.)

[*Dictionary of Economic Products*, Vol. 1., A. 758.]

ALKALIS, ALKALINE EARTHS, ALKALINE ASHES, ALKALOIDS, ETC.

A Review of existing information in which are brought out the chief commercial facts regarding these substances. By GEORGE WATT, M.B., C.M., F.L.S., C.I.E.

It would be beyond the scope of this review to deal with the substances indicated by the heading given to this article in any pretention to completeness, but it might almost be said that the industrial progress of a country can be judged of by the extent to which it produces the *Alkalis* required by its own industries.

In its restricted sense the term *Alkali* might be said to denote *ammonia, potash, soda, Lithia*—the *Alkalis* proper. But in a wider signification it embraces the *Alkaline Earths*, viz., the hydrates of the metals *barium, calcium* and *strontium*. These all possess to a certain extent the properties usually attributed to the alkalis. So in a like manner the *Alkaline Ashes* are very largely crude alkalis and even alkaline earths obtained by burning certain plants. Lastly the *Alkaloids* such as *aconitine, morphine, quinine*, etc., have been described as the *Organic Alkalis*.

The distinctive features of these compounds may be said to be their solubility in water, their neutralisation of acids, their corrosion of animal and vegetable substances and lastly their property of changing or inverting vegetable colours, such as litmus.

In all fairness it may be said of India that it does not possess any industry (pursued on modern scientific methods) for the production or refinement of the alkalis, alkaline earths and their salts.

ALKALIS.

Classification.

Distinctive Features.

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ALKALIS.

*Alkalis, Alkaline Earths, Alkaline Ashes, etc.*MATERIALS
HERE DEALT
WITH.

Such manufactures as do exist (if common salt be for the moment left out of consideration) are a century behind the times and consist mainly in the production of saltpetre, pearl-ash, barilla and the like.

For convenience the following key may be here given to the substances dealt with in the remarks that follow :—

I.—ALKALIS, page 107.

1. AMMONIA AND ITS SALTS, page 108.
2. POTASSIUM AND ITS SALTS, page 109.
 - (A) CARBONATE OF POTASSIUM, page 109.
 - (a) Pearl-ash, page 109.
 - (B) POTASSIUM NITRATE OR SALTPETRE, page 111.
 - (C) OTHER POTASSIUM SALTS, page 114.
3. SODIUM AND ITS COMPOUNDS, page 115.
 - (A) CARBONATE OF SODA, page 115.
 - (a) Réh, page 117.
 - (b) Barilla, page 126.
 - (c) Saltworts, page 129.
 - (B) BORAX, page 132.
 - (C) CAUSTIC SODA, page 134.
 - (D) COMMON SALT, not here dealt with.
 - (E) GLAUBER'S SALT, page 135.

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4. BARIUM AND ITS SALTS, page 136.
5. CALCIUM AND LIME, page 137.
 - (A) CARBONATE OF LIME, page 137.
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6. STRONTIUM AND ITS SALTS, page 148.

AMMONIA.

- I. AMMONIA and its SALTS ; (*Dict. Econ. Prod., Vol. I., 219-20*).

This alkali is in Europe and America very largely prepared from "gas liquor" or "bone liquor" or from "volcanic salts." It is not manufactured to any appreciable extent in this country, for the simple reason that none of the crude materials named are to be had in sufficient abundance. The chief preparations and salts are (a)

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Not manufac-
tured in
India.

Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)

ALKALIES

Liquor Ammonia used as medicine, as a chemical and as a solvent for resins and for certain active vegetable principles, thus forming varnishes and ammoniated tinctures. Of the latter class may be mentioned the "Essence of Ginger," employed in the manufacture of gingerade and ginger beer; of the former the hatter's varnish, which consists of shellac dissolved in ammonia and alcohol.

The salts are (b) the **Chloride** (*Narasára* or *Nausadár*) of importance as a material from which to manufacture other salts of ammonia, also essential in galvanizing, and in galvanic batteries and as an alkaline flux. (c) The **Sulphate** which is largely employed as a manure. (d) The **Carbonate, Sulphide, Oxalate, Nitrate, Phosphate, and Bromide**, all of which take important places in the arts and industries of every country and may be said to be entirely imported by India.

2. **POTASSIUM or POTASH**: (*Dict. Econ. Prod.*, Vol. I., page 167; II., 152-4; VI., Part I., 332).

(A) **CARBONATE OF POTASH**.—This is the chief source of **CAUSTIC POTASH** and the two compounds may, therefore, be dealt with collectively in this place. The carbonate in its crude form is often called **POTASHES** or **PEARL-ASHES** and in Bengali *Sarjika*, in Hindustani *Jon-khár*, or *ivak-chár*, and in Sanskrit *Pavakshára*. Of the other provincial names the following may be quoted:—*jhar-ka-namak*, *jhadicha-mitha*, *mara-vuppu*, *manu-vuppu*, *búdice-vuppu*, *káram*, etc.

Sources.—Formerly the European supply of the crude material from which this substance is manufactured, was very largely the **PEARL-ASH** or **WOOD-ASH** obtained from America, Canada and Russia, etc. While the production of pearl-ash has steadily declined with the advance of the traffic in more scientific and less wasteful materials, the imports into Europe of pearl-ash have not been entirely discontinued. Caustic potash is usually manufactured from the carbonate and this is procured:—(a) From the ashes of plants. (b) From the soil (due to the disintegration of felspar and other silicates and the ultimate combination of their potash with carbonic acid), also numerous methods patented for the accomplishment of this same result artificially. (c) From the sulphate of potassium, produced by the decomposition of the chloride through the agency of sulphuric acid followed by fusion of the resulting sulphate with limestone and charcoal, in other words a process almost identical with the **Le Blanc** method of treating soda. (d) From **SUINT** or the wool of sheep impregnated with the sweat that exuded from the bodies of the animals. (e) Beet-root **VINASSE**.

AMMONIA.

Essence of ginger.

Hatter's varnish.

The Salts.

POTASSIUM.

PEARL-ASH.

Vernacular names.

Sources.

Conf. with Barilla.

Manufacture of.

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ALKALIS.

Alkalis, Alkaline Earths, Alkaline Ashes, etc.

PEARL-ASH.

Yield in
various
plants.Carbonate of
Potash—A
by-product
in Beet-
sugar.PEARL-ASH.
Plants used
in India.

Of plants it may in general terms be said that herbaceous annuals contain more pearl-ash than woody arborescent plants, but even of the same plant the succulent young parts are more highly charged than mature tissues. Of different plants, 1,000 parts of pine contain on an average only 0.45 parts of potash, oaks 0.75, vine shoots 5.50, ordinary straw 5.8, ferns from 4.25 to 6.26, Indian corn-stalks 17.5, nettles 25.03, wheat straw before earing 47.0, wormwood 73.0, and beet about the same amount. These facts naturally suggest the plants best suited for the preparation of pearl-ash, and the immense development within recent years of the beet-sugar industry at once awakened an interest in carbonate of potash as a by-product that might supplement the returns of beet cultivation. This has been actually turned to account.

Indian Sources of Pearl-ash.—The following may be given as the principal plants employed in India for the preparation of pearl-ash:—

Achyranthes aspera.
Adhatoda Vaslea.
Alstonia scholaris.
Amaranthus spinosa.
Bamboo ash.
Borassus flabellifer.
Butea frondosa.
Cæsalpinia Bonducella.
Calotropis gigantea.
Cassia Fistula.
Cedrus Deodara.
Erythrina indica.
Euphorbia nerifolia.
Euphorbia Tirucalli.
Gmelina arborea.

Holarrhena antidysenterica.
Hordeum vulgare.
Indigofera tinctoria.
Luffa ægyptiaca.
Musa sapientum.
Nerium odorum.
Pennisetum typholideum.
Plumbago zeylanica.
Pongamia glabra.
Shorea robusta.
Stereospermum suaveolens.
Symplocos racemosa.
Terminalia bellerica.
Vallisneria spiralis.
Vitex Negundo.

Crude Indian
Alkalis.

The crude ashes obtained from the above and such like plants are the chief sources of the potash salts employed by the people of India in their arts, sciences and medicine. According to Professor Giacomini the ash of *Adhatoda Vasica* is exceptionally rich in potash.

SOAP.
GLASS.

DYES.

Uses.—In Europe carbonate of potash is largely in demand for the manufacture of certain soaps, after having been converted into the caustic. It is also essential in the formation of potash-glass and enters into many tinctorial and textile processes, such as the dyeing of Turkey red and of Arnotto (*Bixa Orellana*). In India it would be almost impossible to overestimate the extent to which a crude carbonate of potash is employed by the people of this country. A better selection of plants or improvements in the methods pursued for the production of pearl-ash are subjects, therefore, of no small importance.

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Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)

ALKALIS.

It may accordingly be remarked that it is surprising that while immense tracts of mountainous land are in India injuriously covered with various species of wormwood (*Artemesia*), except as a manure used locally, the ashes of these plants are not apparently utilized by the people. From the high percentage of carbonate of potash which they contain, the preparation of pearl-ash from the wormwoods might be confidently recommended to the poorer inhabitants of the temperate regions of India as a useful new industry.

Much attention has recently been given both in the United States and in Great Britain to the value of wood-ashes as a manure. Potash is admittedly an essential constituent in plant-food, and although the amount present in the ash of different plants varies greatly, the importance of potash to practically all cultivated plants cannot be denied. It is, as already explained, more abundant in the actively growing parts than in the matured stems, hence its intimate relation to life and its necessity as an article of plant-food. Potash is present in all clayey soils but it need not necessarily exist, even in such soils, in a condition available for the plant. Marshy land and land with much sand may be said to require potash fertilizers.

In Bombay, especially in the rainy tracts, the system prevails of *rabbing*, as it is called, the seed-beds. This consists in burying brush-wood, boughs of trees, cow-dung, etc., etc., under a thin layer of soil, then firing the mass. In this way the soil becomes highly charged with wood-ashes, the most important constituent of which is doubtless potash. It is found that the finer qualities of rice can alone be grown when the seed has been previously germinated on *rab*-beds and later on transplanted to the fields. It would be well, in connection with the subject of potash as a manure, for the reader to consult Dr. J. W. Leather's admirable papers on *INDIAN MANURES*, in *The Agricultural Ledger* No. 8 of 1897 and *INDIAN SOILS* l. c., No. 2 of 1898.

(B) **POTASSIUM NITRATE.** (*Dict. of Econ. Prod.*, Vol. VI., Pt. II, 431-47.)

NITRATE of **POTASH**, **NITRE** or **SALTPETRE**, according to U. C. Dutt (*Mat. Med. of the Hindus*), was unknown to the ancient Sanskrit authors and its name *Soráka* which occurs in the more recent publications, is but "Sanskritized from the vernacular *Sorá*, a term of foreign origin" He then adds "The manufacture of nitre was, therefore, most probably introduced into India after the adoption of gunpowder as an implement of warfare." But as opposed to this view it seems fairly certain the Natives of India had fireworks long before the invention of guns. Saltpetre is known in the vernaculars as follows;—*Suriakhar*, *shorá*, *shora-kalmi*, (refined), *potti-luppu*,

PEARL-ASH.

A useful
New
Industry.

MANURE.

Presence in
the soil.

Rabby
seed-beds.

SALTPETRE.

Vernacular
Names.

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ALKALIS.

Alkalis, Alkaline Earths, Alkaline Ashes, etc.

SALTPETRE.

pet-luppu, veti-luppa, sandawa, yan-zin, etc. *Shorá* appears to be its Persian name.

Localities of Production.

Occurrence and Production.—The saltpetre of Indian commerce is derived mainly from Behár (chiefly Gya, Tirhut, Saran and Champáran), to a much less extent from the United Provinces of Agra and Oudh (such as Cawnpore, Gházipur, Allahábád and Benáres) with still smaller quantities from the Pánjáb, Kashmir, Central India (Bhind and Jwargarh) Bombay, Madrás (such as Coimbatore, Salem, Kistna, Nellore, Trichinopoly, Madura) and lastly from Burma (Tenasserim).

Presence in the soil.

It occurs as a natural efflorescence on the surface of the ground mixed with chlorides of potassium and sodium, nitrate of lime, and sulphate of soda. But the saltpetre lies as it were in patches being more abundant according as carbonate of lime and sand predominate. (See Stevenson's *Paper* (1833) reprinted in *Dictionary of Economic Products*.) Mr. F. Ashton in an interesting report on salt (sodium chloride) in *The Agricultural Ledger*, No. 13 of 1900, alludes incidentally to saltpetre in the following passage:—

Nitrating Ferments.

“Owing to the presence of potash and decaying organic matter being more abundant in towns and villages than elsewhere, the nitrating ferments show the greatest activity in the soil of such localities and the profitable manufacture of saltpetre becomes possible and is carried on. A proportion of sodic chloride is always present in the nitrous soil which is utilized, and this when separated from the saltpetre with which it is in mechanical admixture is termed “Salt-petre Salt.” When first obtained from nitrous soil, saltpetre is in an impure state, owing to the presence of earthy matter and chloride of sodium and other salts, and it is termed “**CRUDE SALTPETRE.**” This crude substance has to be purified before it is fit for export, earthy matter being removed and foreign salts (sodic chloride particularly) eliminated as much as possible. This purification is effected in refineries, which are scattered over Northern India and Behár, and there are also a few in Calcutta. During 1898-1899, there were 36,997 crude saltpetre factories and 570 refineries in Northern India and Behár, and 13 refineries in Calcutta. The refineries utilised 722,714 cwts. of crude saltpetre and produced 408,335 cwts. of the refined substance in a condition fit for export.” Stevenson, Baden Powell, and many other writers have recorded the circumstance that saltpetre forms in greatest abundance on ruined houses of deserted villages or on the mud-walls of inhabited dwellings, but the action of a fermentative germ in bringing about the formation of nitre is one of the modern discoveries that is engaging attention in India.

Crude Saltpetre.

REFINERIES.

Formation Near Human Dwellings.

Uses of Nitre.—It is hardly necessary to enumerate these as they are so well known. It is an important ingredient in

Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)

ALKALIS.

Gunpowder, owing to the large volume of oxygen which it contains, the ease with which it parts with its oxygen and the fact that it does not readily absorb moisture from the air. On the other hand sodium nitrate is preferred to potassium nitrate for the manufacture of *nitric acid* both because it is cheaper and yields about 7 per cent. more acid. In India saltpetre is used as an *assistant* with certain animal dyes such as lac and cochineal. In *medicine* it is sometimes prescribed because of its diaphoretic properties. Its merits as an *antiseptic* in preserving fish and meat are well known. As *manure* it is much appreciated, especially for wheat and tobacco (see *The Agricultural Ledger No. 8 of 1897, page 33*) and in India it is at times employed as a *flux* in glass-making.

Trade and History.—In view of the observations already offered, regarding the backwardness of India in the production of the alkalies required for her arts and industries, no study could be more instructive than the history of saltpetre. It might be said that the rise of the East India Company into a position of political importance was intimately associated with the early export trade in Indian saltpetre. The Company were bound down by treaty to supply to Great Britain annually, in times of peace, with a fixed quantity (500 tons), before they were free to offer any for sale to other nations; and they were at the same time prohibited from cornering the market, in times of war, by a maximum rate being fixed for the British supply. But saltpetre was essentially a speculative article since the price would suddenly rise, on the slightest suspicion of war, and fall as quickly and abnormally with the report of peace. For a century or more, however, saltpetre and sugar were the exports most highly valued as “dead weights” for ships carrying silk, silk-goods, muslins and other expensive but light goods. This unsatisfactory state of affairs continued until chemical science furnished Europe and America with new, cheaper and more regular sources of supply. In 1846 the discovery was made that Chilian saltpetre (sodium nitrate) could be converted into potassium nitrate, thus rendering a practically limitless supply available for the demands of commerce. It was, therefore, only what might have been anticipated, that interest in the natural salt of India—a salt obtained by a crude process and one which was constantly liable to adulteration, through the impecuniosity of the manufacturers or the criminality of the traders, should greatly decrease or at all events should cease to expand when brought face to face with scientific and accurate manufacture. In support of this contention I would mention that the exports from America of Chilian saltpetre were in 1830 only 935 tons but 60 years later they were 1,033,100 tons valued at £ 8,000,000, of which Germany took in 1890, 344,209 tons and in 1899, 531,034 tons. But the still cheaper

SALTPETRE.

Gunpowder.

Nitric acid.

Assistant
Antiseptic
Manure.Trade
History of
Salt petre.Political
Aspects.Dead weight
Cargo.Crude versus
Pure Salt.

ALKALIS.

Alkalis, Alkaline Earths, Alkaline Ashes, etc.

SALTPETRE.

Half-Century's Traffic.

Disturbing Influences.

Recent Transactions.

production from potassium chloride enabled Germany to not only discontinue her demands on India and Chili for saltpetre but to commence to export that salt to all parts of the world.

The Indian exports of saltpetre from Calcutta were in 1845 a little under $\frac{1}{2}$ million cwts., valued at 35 lakhs of rupees. During the succeeding half century they fluctuated but marked rather a downward than forward course, so that in 1894-95 they stood at 325,985 cwts. valued at Rs. 41,13,650. In addition to new sources of supply disturbing the markets, discoveries have been made that have curtailed many of the older outlets for saltpetre such as the substitution of new explosives for gunpowder and of frozen for preserved meats, etc. But to conclude this brief review it may be said that during the past five years (1896-97 to 1900-1901) the exports have shown considerable fluctuation and if anything have slightly improved, the average of the years in question being 411,053 cwts. The actual exports of last year were 346,388 cwts. valued at Rs. 33,95,324, of which the United Kingdom took 100,863 cwts., the United States 75,462 cwts., China (Hongkong) 104,144 cwts., the balance 65,919 cwts., to all other countries.

OTHER POTASSIUM SALTS.
Bicarbonate
Oxydising
Agent.
Chlorate.

Matches.
Fireworks.
Chloride.

Potassic
Minerals.

Kelp.

Bichromate.
Catechu.

Cyanide
Ferrieyanide
and Ferro-
cyanide.
Electro-gild-
ing.

Dyeing.
Iodide
Oxalate
Binoxalates.

(C) **OTHER POTASSIUM SALTS.**—In addition to the compounds of potash already indicated the following may be mentioned:—(1) **Bicarbonate**, chiefly used medicinally as a diuretic and antacid. (2) The **Chlorate**—a salt which readily parts with its oxygen and on that account is utilized as an oxydising agent in calico-printing. Together with phosphorus it is employed in the manufacture of matches and in the production of fireworks and detonators. (3) The **Chloride**—this closely resembles ordinary (or table) salt and similarly is often found native either pure or in combination with other metallic chlorides, the mixture being known as **POTASSIC MINERALS**. It may also be obtained (and used formerly to be largely manufactured and is so to some extent at the present day) from the ashes of sea-weeds or **KELP**. The chloride is also procured from brine-springs such as those in the South of France. (4) **Bichromate of Potash** is a salt of considerable importance, owing to its being extensively employed in calico-printing and dyeing as also in fixing catechu. (5) **Cyanide Ferrieyanide** and **Ferrocyanide** are salts of potassium that each hold important places in the arts and industries. Cyanide is essential in photography, in electro-gilding and plating. Ferrocyanide is employed in the preparation of the ferricyanide and both salts are practically indispensable in the dyeing industry of Europe. (6) **Iodide of Potassium, Oxalate of Potassium** also (the **Binoxalate** or "**SALT OF SORREL**" or "**SALTS OF LEMON**"), the **Sulphate of**

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Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)

ALKALIS.

Potassium a very important manure (and the *BISULPHATE*) and the **Tartrate of Potassium** (or "Cream of Tartar," are all salts of the greatest importance in the industries.

OTHER
POTASSIUM
SALTS.Bisulphate
Tartrate.

SODIUM.

3. SODIUM AND ITS COMPOUNDS. (*Dict. Econ. Prod. Vol. II., 154.*)

The term soda strictly speaking denotes the oxides of the metal but it is also used for the hydrate and the carbonate. The last mentioned is not only the most important commercially but it is the compound from which the majority of the other soda salts are made or can be made and, therefore, it may be dealt with in greatest detail.

Definition.

(A) **CARBONATE OF SODA.**—This important salt exists in nature and is as a rule the most abundant and, from the point of view of the agriculturists, the most objectionable ingredient of the soluble sodium salts found in the soil. This subject will be dealt with in a further paragraph under the heading of *REH* deposits (page 117). It may be here observed that from such deposits carbonate of soda can be isolated and purified commercially or a crude mixed salt can be made that may be utilized in the manufacture of other alkalis or in the glass, soap and other trades. Sodium carbonate in an even purer state may be obtained from the brine of certain lakes such as the Lonar in Berar.

CARBONATE
OF SODA.

Sources.

Manufacture from Kelp.—In Europe some few years ago a large trade used to exist in the separation of sodium carbonate from calcined sea-weeds—*KELP*—or salt-worts—*BARILLA*. Indeed to this day it may be said that *SALSOLA SODA* is still regularly cultivated both in France and Spain because of the large amount and fine quality of soda obtained from its ashes. And it was the loss of their regular supplies of *BARILLA*, during the wars with Spain, that compelled the French people to seek for new sources of barilla and finally led to *Le Blanc* taking out a patent in 1792, for the artificial manufacture of carbonate of soda from common salt. The calcination of sea-weeds is pursued as a rule for the purpose of obtaining potash rather than soda and at the present day "kelp" is much more frequently spoken of as the source of iodine than of either of the alkalis named.

From Plants,
(Kelp and
Barilla).Origin of
French
Discovery.

Iodine.

Manufacture from Sea Salt.—The artificial manufacture of soda has within the past century attained such perfections and proportions as to have almost revolutionised the chemical works and industries of Europe. By the *Le Blanc* process common salt is reduced by means of sulphuric acid to sulphate of soda. It is next converted into carbonate of soda and sulphate of lime by means of heating with chalk and coal, and lastly by lixiviation, the soluble

From Com-
mon Salt.Le Blanc Pro-
cess.

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ALKALIS.		Alkalies, Alkaline Earths, Alkaline Ashes, etc.
CARBONATE OF SODA.		carbonate is separated in the form now known as soda-ash. The only other process that need be mentioned here is that known as the "Ammonia soda." This depends upon the fact that when carbonic acid is passed through a solution of common salt and ammonia, bicarbonate of soda and chloride of ammonia are formed. This process has been recently carried to a high state of perfection as may be seen from the following facts:—The German production of ammonia soda was 56,500 tons in 1884 and 210,000 tons in 1894.
Ammonia Soda process.		
Soda-ash.		<i>Soda-ash.</i>—By far the greater portion of the carbonate of soda used at the present day may be said to be now obtained by either of the processes indicated. In the production of carbonate of soda by the Le Blanc process much depends on the kind of common salt used and the quality of the chalk or limestone and coal employed. The salt generally preferred is the Cheshire or Worcestershire brine, because of its cheapness, purity, and uniformity of crystals. The soda-ash obtained after lixiviation in the Le Blanc process is now preferred by the soap, glass and paper trades to refined carbonate of soda or even the much purer bicarbonate of the ammonia-soda process. The waste materials left in the lixiviating tanks are utilized in the manufacture of hyposulphite of soda. But the greatest economy in the carbonate of soda industry was effected by the manufacture of sulphuric acid from pyrites in place of the expensive Sicilian sulphur, and it might be said by the recovery of the sulphur in the Le Blanc process or the ammonia in the other process from the waste materials of the lixiviating tanks. In fact in the chemical industries of the present day there can hardly be said to be any "waste materials."
Qualities.		
Hyposulphite of Soda.		
Sulphuric Acid.		
Sulphur.		The extensive deposits of copper pyrites that exist in India if utilized in the combined production of copper and sulphuric acid and the still further manufacture of the phosphatic deposits of India and adjacent countries into superphosphates should open a highly lucrative field of enterprise for India. As an exemplification of such results it may be added that the production of sulphuric acid from iron pyrites was in Germany 358,149 tons in 1882 and 754,151 tons in 1898 and of that large quantity only 25,000 tons were exported, the balance being used up in the exceedingly important German chemical industries which within the past three quarters of a century have expanded from being nominal to a valuation of £50,000,000.
India's Future Chemical Works.		
Refined Soda.		<i>Further Stages.</i>—The quality of soda-ash is estimated by the percentage of sodium it possesses. But for the finer sorts of glass and for many other minor purposes a <i>REFINED CARBONATE</i> is required. This is obtained by re-dissolving the ash in hot water, settling, boiling down and re-furnacing—the result being a purer quality of carbonate.

Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)

ALKALIS.

SODA CRYSTALS may be said to be a well known special preparation that contains 10 parts of water in combination with the carbonate. For household purposes of cleaning, bleaching, etc., soda crystals are still sold. The other substances obtained from sodium carbonate that may be here mentioned are the bicarbonate of soda and caustic soda. Before proceeding to deal with the last mentioned, the Indian manufacture and sources of supply of carbonate of soda may be dealt with very briefly. These have already been incidentally mentioned, namely, *rêh* and *barilla*, but to the former must be added, the sources of natural carbonate derived from the waters of certain lakes such as the Lonar in Berâr.

(a) **Reh or Saji-mati.**—(*Dict. of Econ. Prod., Vol. VI., Part I., 400—27.*)

Composition of Reh.—As already explained this is an efflorescence that occurs on the surface of the ground, in most provinces of India. It may be said to be a mixture of the following salts:—sodium carbonate (*saji*), sodium sulphate (*khâri*) and sodium chloride (common salt or *namak*). In most localities the carbonate predominates but in others the sulphate; and in the latter case it is very often associated with potassium nitrate or even with calcium nitrate. Soils badly impregnated with soluble alkali salts are variously designated as *ûsar*, *bhâdi*, *rêhâl*, *rêhâr* and *kalar* (*kalr*), etc., though also employed, denotes as a rule the presence of common salt just as *khâri* usually indicates a soil containing the sulphate. In passing, it may be here remarked that the earlier investigators of these lands speak of the sulphate as being the most abundant. Yule-Burnell's *Glossary of Anglo-Indian Words* defines *rêh* as an efflorescent sulphate of soda mixed with chloride and occasionally carbonate. Voelcker (*Report, Improvement of Indian Agriculture, page 37*) says of *rêh* "The salts are principally impure carbonate of soda, but sulphate of soda also occurs largely and with them are found common salt and salts of lime and magnesia."

Rêh often occurs in such abundance as to give origin to large tracts of desert—and constantly increasing tracts—the surface being literally encrusted with a white snow-like deposit (hence the name *rêh* or *rêj*=shining)—or the salt may be invisible and only present to an extent sufficient to greatly lower fertility or while still hardly visible, may yet render the soil more or less sterile for at least half the year.

Formation of Usar.—It would be beyond the scope of this review to deal fully with all the opinions that have been advanced regarding the source and formation of these alkali deposits. These opinions vary in degree and detail rather than in fact and mainly in

CARBONATE OF SODA.

Soda Crystals.
Domestic Uses.

Bicarbonate.

Caustic.
Indian Sources.

REH.

Composition.

Variation.

Amount of
Salts.

FORMATION-
Varying
Opinions.

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ALKALIS.

Alkalis, Alkaline Earths, Alkaline Ashes, etc.

REH.

Percentage Present.

Sterile Soils.

Saltworts.

Vigorous soils.

Drainage.

Soil permeation.

Conditions of Efflorescence.

consequence of what might be called professional bias. Medlicott (at one time Director General of the Geological Survey) began the study of this subject early in the sixties, and as a member of the Réh Committee of 1877, he wrote a masterly report which may be said to contain all that we know, or are likely to know, regarding the formation and movement of the soluble alkali salts within the soil. These, he tells us, are formed from normal soil materials by the disintegration caused through the growth of plants and tillage. The silicates are broken up by the action of heat, air, water and carbonic acid, etc., with the manifestation of the various alkalis that are formed and re-formed during the several changes that ensue. During the production and maintenance of fertile soils carbonate of soda, for example, is, as a rule, a transitional compound and is destroyed with the elaboration of other and more essential constituents, especially in the presence of lime. In most fertile soils the percentage of that carbonate is accordingly remarkably low. In fact the total of soluble soda salts in good soils rarely exceed 0.1 of which ordinarily one-half may be the carbonate. Crops, more especially cereals, may, however, be grown on soils that contain 0.1 per cent. of carbonate of soda but 0.2 per cent. is sufficient to cause serious injury if it be not found fatal, except perhaps to the so-called saltworts or saltbush—plants that are actually found to luxuriate on briny soils or littoral swamps. At times, however, as already observed, the surface soil may become encrusted with soluble salts, as much as 2 to 6 per cent. or much more being often present. Normally these soluble alkalis are carried by the rain water to the sub-soil and a certain percentage are there absorbed or detained mechanically, in order to meet plant necessities. The soil might in fact be described as a vital filter which, when in a healthy and vigorous condition, retains what is necessary for the support of plant life and rejects what is unnecessary or injurious. A soil is vigorous when it is completely and freely permeated by the water that is carrying its supplies of soluble salts and other chemical re-agents and of heat, air, etc., to every depth and particle. Drainage is in fact to the soil what circulation of blood is to the animal. The soil is abnormal and diseased when, from whatever cause, free permeation is interrupted. The evil consequences of even a temporary cessation of soil permeation may be exaggerated under certain conditions such as (I) recurring periods of hot parching winds, (II) absence of soil covering (*i.e.*, wild herbage or crops and trees) and (III) defective tillage (*i.e.*, superficial ploughing or puddling during flood). These are the very conditions that produce *reh* efflorescence, aided by (*a*) the chemical nature of the original soil materials; (*b*) the physical attributes (or texture,

<i>Alkalies, Alkaline Earths, Alkaline Ashes, etc.</i> (G. Watt.)	ALKALIS.
as it has been called) of the soil (<i>i.e.</i> , abundance of clay and the condition of the clay; abundance of sand or of lime, etc.); and (<i>c</i>) the accidental or irregular distribution of (<i>a</i>) and (<i>b</i>) brought about through countless ages of water action both during the formation of the alluvial plains and subsequently. For particulars regarding the association of concretionary lime (<i>kankar</i>) with <i>reh</i> the reader is referred to page 140.	REH.
Towards the close of his report, Medlicott emphasises the necessity for sub-soil drainage in the following words:—"The one measure that is of obvious necessity under any aspect of the case, and that may be at once put in hand, is deep main drainage. It would certainly alleviate the evil in what are at present the most threatening cases, and it would also be a necessary feature of any general scheme of improvement."	Sub-soil Drainage.
Capillary Attraction. —Mention has been made of the salts being carried to the surface by capillary attraction. Dr. Center (then Chemical Examiner to the Panjáb Government) wrote in 1880 a most valuable " <i>Note on Reh or Alkali Soils and Saline Well Waters</i> ," in which he dealt in great detail with the movement of these salts within the soil and their temporary accumulation on the surface. Hilgard and Loughridge, in connection with the Californian Experimental Station of Tulare, have carried these investigations to their final issue by tracing, in every detail, the actual movement of the salts in sterile soils, before and after irrigation, and have exhibited their results graphically, in direct correspondence with a most critical analysis of practically every inch of soil to a depth of four feet. They have also demonstrated beyond all dispute that this movement to and from the surface is directly a result of imperfect drainage in conjunction with severe surface evaporation.	Capillary Action.
Manuring and Tillage. —Mr. Baden Powell (<i>Punjab Products</i> , published 1868) wrote "With regard to the actual practice of the agriculturist in dealing with <i>Reh</i> land it may be observed, that in many places drainage has been turned into good effect. If the <i>Reh</i> land is not very heavily impregnated, the natives give it constant ploughing, free watering and manure, and this generally renders the land productive, at least for second-rate crops." Some time previously Dr. Brown (then Chemical Examiner to the Panjáb) had investigated the use of lime salts as a manure to be employed in the treatment of <i>reh</i> soils and his views were published by Mr. Baden Powell as follows:—"When the deleterious sulphates and carbonates are mixed with <i>any soluble salt of lime</i> , such as the nitrate of lime, decomposition occurs and nitrate of soda is formed while carbonate and sulphate of lime are produced. Carbonate of lime is insoluble	Movement of the Salts.
	Causes.
	TREATMENT.
	Drainage.
	Manures.
	Use of Lime Salts.

ALKALIS.	<i>Alkalis, Alkaline Earths, Alkaline Ashes, etc.</i>
REH. Nitrates. Formation of a Nitrate Manure. Farm-yard Manure. Green Manure. American Reclamation Methods. Gypsum. (Conf. with Gypsum, page 145.) Mechanical Texture. A Corrosive Salt. Antidote to Alkali. Tilthy Condition Im-possible.	in pure water and has no power of injuring plants while nitrate of soda and sulphate of lime are beneficial in supplying them with nitrogen, the former by direct decomposition of its acid and the latter by absorbing ammonia from the air. Nitrate of lime is formed whenever organic matter decomposes in contact with carbonate of lime. Nitrate of lime might be made by treating a mixture of <i>kankar</i> and water, with impure but cheap nitric acid made by distilling nitre and <i>kahi</i> (sulphate of iron earth) together. The nitrate can also be obtained by mixing animal manure with chalk or lime, in large heaps exposed to air but sheltered from rain.” Some years later Dr. Brown addressed a letter on this selfsame subject to the Financial Commissioner to the Panjáb, in which he advocated the use of farm-yard manure and green manure, with such plants as <i>Calotropis gigantea</i>, on the ground of their supplying the nitrogen which, in combination with the lime (naturally present in all <i>kalr</i> soils), would tend to reduce the carbonate of soda to a harmless condition. Dr. Center (who succeeded Dr. Brown) wrote a long and most instructive report on the chemistry of the <i>úsar</i> soils and confirmed in the most striking way Dr. Brown’s recommendations for lime nitrate. He also gave an account of the operations in the Utah Basin and other parts of America where heavy nitrating manures were employed as a remedial measure for alkali soils. <i>Use of Gypsum.</i>—Later on the sulphate of lime (gypsum) gained a well-deserved reputation as a chemical substance that might be employed with great advantage in the neutralisation of the sodium carbonate in <i>úsar</i> soils. On this subject, for example, Dr. Romanis (Chemical Examiner to the Government of Burma) in 1884, reported on the soil of Bulandshahr District in the United Provinces. He was of opinion that the fault lay more in the mechanical texture than in the chemical nature of the soil. “It is well known,” wrote Dr. Romanis, “that an alkaline substance like sodium carbonate is far more injurious to plants than neutral salts like the sulphate and chloride. That alkali can be neutralised by sulphate of lime (gypsum) which produces carbonate of lime and sulphate of sodium.” Professor R. Wallace has repeatedly urged the importance of gypsum “as an antidote to alkali soils.” In his <i>Rural Economy and Agriculture of Australia and New Zealand</i> (page 183) he says: “The carbonate of soda is by far the most injurious of all the alkali salts enumerated under the three headings. This arises not only from its corrosive power, but is also due to the peculiar action (shared with the carbonate of potash) which makes it almost impossible to produce a tilthy condition in

<i>Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)</i>	ALKALIS.
true clays. They are maintained in the most impalpably divided condition—that of well-worked pottery clay, “in place of the flocculent though tilthy state it assumes in a cultivated soil.” So far as I can discover Dr. Voelcker (<i>Report, Improvement of Indian Agriculture</i>), makes no mention of the use of gypsum or any other lime salt in the reclamation of <i>úsar</i> lands.	REH.
The next most important step, in the study of the chemical treatment of <i>úsar</i> soils, may be said to be Dr. Leather's various papers that have appeared in <i>The Agricultural Ledger</i> (<i>Nos. 12 and 13 of 1893 and Nos. 5, 7 and 13 of 1897</i>). These give extensive analyses of soils, waters, etc., from the entire alkali area of India. They contain the results of practical experiments to test the amount of soluble alkali salts that may exist in soils before these become poisonous to vegetation. They indicate the plants that first show signs of succumbing to the influence of these salts and the amount of each salt that proves fatal. By special pot cultures of various plants Dr. Leather proved that sodium carbonate is (as has always been upheld) infinitely more injurious to plant life than are any of the other soda salts. But perhaps the most instructive part of Dr. Leather's researches was the demonstration of the physical property (alluded to above by Romanis, Wallace and others) possessed by carbonate of soda which greatly augments its injurious chemical influence on plants. While filtering the soil in order to obtain their soluble salts, Dr. Leather observed that certain soils could practically not be filtered. A little muddy water percolated through at first but very soon the surface of the filter cloth became coated with a perfectly impenetrable layer that was quite impervious and further filtration practically ceased. The soils that manifested this peculiarity were those most highly charged with carbonate of soda. To remedy this defect Dr. Leather experimented with gypsum and soon ascertained that its well-known merit as a chemical manure, in the reclamation of <i>úsar</i> soils, rested as much on the destruction of their power to form an impervious deposit as in the reduction of the “white” to the “black alkali.” It would thus appear that should climatic and soil conditions exist, sufficient to give origin to a <i>reh</i> efflorescence containing carbonate of soda, there must sooner or later be produced (at a certain position or depth) an impenetrable layer through which surface percolation of water would be impossible. This water-proof layer may not be sufficiently developed to be visible to the naked eye as a “hard pan,” but if carried near to the surface it will give origin to a crust of salt. It may thus be inferred that sub-soil drainage, below an impervious layer would be next to useless, unless the soil be chemically	Recent Investigations.
	Percentage of Alkalies.
	Action of Sodium Carbonate Demonstrated.
	Physical Property of Soil also Demonstrated.
	Principles Involved.
	Hard Pan.
	Initial Action.

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ALKALIS.		Alkalis, Alkaline Earths, Alkaline Ashes, etc.
REH. Tree Cultivation.		treated with some of the soluble lime salts or be penetrated by deep pits filled in with fresh soil for tree cultivation. It would indeed seem probable that the surface vegetation that has been reported as accompanying successful tree cultivation may be due very largely to the pits dug for trees having acted as openings through the impenetrable layer by which the soluble salts of the surface have been washed into the natural drainage.
Is complete Neutralisa- tion Essen- tial ?		By way of concluding these observations regarding gypsum, it may be suggested that it does not seem necessary to assume that the exact amount of that salt which would be required chemically to neutralise the ascertained weight of carbonate present, need be given as a manure, before beneficial results may be looked for. Gypsum is useless without water and unnecessary where the carbonate is absent. Water must be carried right into the soil and through it to the sub-soil. Unless, therefore, a free sub-soil natural drainage exists it must be provided before any heavy expenditure be incurred for gypsum as a manure. At the same time land treated with gypsum should be planted with saltworts or other plants that have been found possible of cultivation. If these can be raised on the soil it seems highly probable, provision may have been thereby made for the injurious salts being washed out of the soil, long before it has been necessary to add, from a financial point of view, a prohibitive amount of gypsum.
Important Factors.		
Saltworts. Soil washing.		
Results.		<i>American Results.</i> —This leads, therefore, very naturally to a brief reference to the admirable investigations and practical results that have been attained by Hilgard and Loughridge in the reclama- tion of alkali wastes in California. These officers performed a most extensive series of experiments and analyses with the result that they arrived emphatically at the same conclusions as our Indian experts, namely, regarding the formation of these salts, their movements in the soil and lastly their treatment with drainage, chemical manures, and selection of crops. The difference between America and India in this matter may be said to be that in the former country the scientific experts were at the same time the administrative staff that had to deal with the alkali wastes. Their observations were not treated as scientific theories but were at once put to practical test, with this result that alkali wastes are in that country not only regarded as comparatively easy of reclamation but have actually been largely turned into some of the most profitable of lands.
Direct Accord with Indian experts.		
Reclamation easy.		
Soil protec- tion.		<i>Helpful Vegetation.</i> —Medlicott urged that to protect the soil from the excessive heat of the summer months and consequent injurious capillary efflorescence, it was most important to alleviate the serious Indian defect, viz., the almost total absence of arborescent

Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)		ALKALIS.
vegetation from the agricultural tracts of the country. But there is an aspect of vegetation that seems to have entirely escaped Mr. Medlicott's observation, namely the employment of certain plants as direct agents in reclamation. It is well known that many plants not only can survive on soils that contain a proportion of alkali that would be fatal to others, but that they actually luxuriate under such soil conditions. Of this nature may be mentioned the saltworts. Long, therefore, before reclamation could be carried to the extent of admitting of ordinary crops or even of arborescent cultivation, the soil might be protected from the sun by saltworts and have at the same time large amounts of its poisonous salts removed by the temporary cultivation of such plants. This subject has not, however, been entirely neglected in India. It was believed that were alkali lands protected from cattle for a number of years or even annually from the close of the rains through the hot months, the plants produced during the rains might be encouraged to survive and even others, including trees, to gradually invade such protected localities, until, in a few years' time, the growth of a soil garment might ultimately prevent efflorescence. Such experiments have actually been conducted and with considerable success. The plant found to first invade the protected barren lands was the grass known as <i>khār úsara</i> (<i>Sporobolus arabicus</i>) which from its vernacular name may be inferred to be a salt loving species. <i>Sporobolus coromandelianus</i> (the <i>bhurburoi</i>) also springs up readily enough but only during the rains. It, however, affords useful fodder, although it does not protect the land from the summer's heat. After partial reclamation the <i>dáb</i> (<i>Eragrostis cynosuroides</i>), the <i>dúb</i> (<i>Cynodon dactylon</i>), the <i>batt</i> (<i>Dyplachne fusca</i>), the <i>janewa</i> (<i>Andropogon annulatus</i>) and several other species readily enough appear. Since fodder is of necessity a pressing need in all parched lands, it is valuable to know the Indian grasses that should be first resorted to in reclamation operations, but it is unfortunate that the true saltworts have not hitherto been seriously investigated in India as desirable preparatory vegetation to any of the grasses named. We read of a few desultory experiments having been put forth to acclimatise the Australian salt-bush, but it does not seem to have occurred to any of our Indian experts that this country possessed perhaps a richer and more varied assortment of indigenous saltworts than is to be found in any other country. In the Panjáb and elsewhere a few of these have been (one might almost say) systematically cultivated for the production of barilla, but not one of them, so far as I can discover, has been seriously investigated as a preparatory crop in <i>úsar</i> reclamation.		REH.
		Direct agents to reclamation.
		Saltworts.
		Protection from cattle.
		Soil garment.
		Invading grasses.
		Fodder a necessity.
		Acclimatisation of Saltworts.
		Barilla-Yielding species.

ALKALIS.

Alkalis, Alkaline Earths, Alkaline Ashes, etc.

REH. study of crops necessary.	It is interesting in this connection to record that halophytic plants when removed from their wild conditions and cultivated as regular crops may be made to live on soils that contain practically no alkali and yet when employed in alkali reclamation they at once take kindly to soils highly charged with these salts. Of this nature may be mentioned all the forms of cabbage, cauliflower, beet, asparagus, etc. These and such like vegetables may be grown luxuriantly on reclaimed salt marshes and alkali impregnated soils, when, for example, most forms of the pea family would readily succumb. Then, again, it has been found that even of the grasses and cereals some species, such as the maize, can stand a quantity of alkali that would be fatal to wheat. These and the like considerations point conclusively to the necessity for a systematic study of the Indian wild vegetation, saltworts, regular crops, fodder plants and trees, with a view to lists of plants being framed in relation to sodium carbonate, sodium sulphate, sodium chloride and perhaps to the total mixed sodium salts. These might start with the amount of each salt present in a soil that would prove fatal to all vegetation, then give the plant found to survive in the highest amount and pass on to exhibit progressively all the others. Such lists, if they dealt with a fairly extensive series of plants, would furnish the urgently needed means of a selection, suited to each province, for cultivation during reclamation operations. In the attempts hitherto made to organise plantations of trees, experiment has in this country, for the most part, been pursued in the least satisfactory manner possible, viz., by laying out large plots of land under trees regarding which very little if anything for certain was known as to their suitability or not to the purpose desired. The trees chiefly experimented with and those most highly commended by Dr. Voelcker and others) have been <i>Acacia arabica</i>, <i>Butea frondosa</i> and <i>Dalbengia Sissoo</i>—all three members of the pea family. Although a certain success has been spoken of as attained, one still feels disposed to suggest that a better selection might be possible. The greatest fault, however, with all the Indian endeavours at reforestation, as with the efforts to produce fodder by enclosing and protecting selected experimental plots, has been the impecunious craving and shortsighted policy of desiring immediate returns from reclamation operations of barren lands. Industrial Uses of Soda.—Incidentally this subject has been already dealt with. Throughout India soda soils are washed and more or less pure carbonate obtained. At one time a fairly large trade was done in this way in South India (Salem, Mysore) and expectations of a considerable development entertained. Licenses are granted in Behár, the United Provinces and elsewhere
Pea Family Plants.	
List of Plants in Relation to Alkali Soils.	
Tree Cultiva- tion.	
Results.	
Shortsighted Policy.	
Industrial Uses.	
Preparation from the Soil.	

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for the manufacture of <i>saji</i> and <i>rasi</i> (two qualities of carbonate of soda) from saline earths. The object in licensing the industry is to protect the revenue, since from the factories concerned fairly large quantities of common salt are educed, especially at the factories and refineries for the production of saltpetre. (For method of manufacture see Glauber's salt , page 135.)	CARBONATE OF SODA. Common Salt Educed.
Carbonate of Soda of a very pure kind is regularly prepared at the Lonar lake of Berár. Ball says (<i>Econ. Geology</i> , page 494), "Blocks of mixed salt are obtained by divers in certain parts of the lake, and the waters of the lake, on evaporation, deposit salts among which the principal is the carbonate of soda. The local names for these products are <i>dalla</i> , which consists of a close collection of acicular crystals, between two compact surfaces; <i>kuppal</i> , a thin kind of <i>dalla</i> , principally of red colour; <i>papadi</i> or <i>papri</i> , a white saline froth."	Lake Supplies. Different Qualities.
Whether obtained from soil efflorescence or from salt lakes by treatment with sulphuric acid, the mixed salts (especially where the greater proportion is already the sulphate), may be reduced to a salt-cake, (similar to that obtained at the first stage in the Le Blanc process of manufacture), and by calcining with lime and coal that may be converted into soda-ash. At Awah, in the United Provinces, an attempt was made, in 1880, to utilize the <i>réh</i> efflorescence in the manufacture of glass and glass-beads. A complete set of tools was imported from Venice, but the following among other conclusions appear to have been arrived at, regarding these and all other experiments at utilizing the alkali deposits in glass-making :—	Preparation from Réh. Glass-making.
(a) The impurity of the alkali prevents the formation of good quality of colourless glass. (b) It is, therefore, necessary to organise chemical works to produce pure alkali. (c) Good beads could be made but doubtfully at a lower price than they can be imported. (d) Improvement of glass manufacture in India would depend on the work being done on a large scale with skilled supervision.	Conclusion.
Wherever soda efflorescence is at all abundant, the Native industry of glass-making (such as it is) is more or less prevalent, especially that of glass bangles. But <i>réh</i> and <i>saji</i> are put to an infinite variety of other uses by the Natives. They are employed for dissolving crude lac and <i>kamela</i> , preparatory to dyeing silk, also for extracting the crimson dye from safflower in cotton dyeing. They are used for bleaching silk, cotton and wool. <i>Saji</i> is employed in making	Native Industries. Dyeing. Bleaching.

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*Alkalis, Alkaline Earths, Alkaline Ashes, etc.*CARBONATE
OF SODA.Paper-
making.Sugar-
manufacture.Tobacco
Adulteration.

Medicine.

Ceramic Art.

Early
Bengal.
Experiments

Black Salt.

Medicine.

Phuli.

Flavouring
for Tea.

BARILLA.

country paper from hemp in Farukhábád. Both salts, in conjunction with shell-lime, enter into the composition of country soap. White *rêh* sprinkled into boiling cane juice is utilized to neutralize the organic acids in the manufacture of sugar very similar to the use of lime (page 142), barium carbonate (page 136) or strontium carbonate (page 148) in Europe. *Rêh* is an adulterant of tobacco and is added to increase the weight. In Native medicine these salts are supposed to be digestive and hepatic.

The effort to utilize the peculiar clays that are in association with carbonate of soda, in the potter's art, has not as yet received the consideration that it deserves, although the ceramic art of India has been the subject recently of special study. As a historic fact, that has escaped the attention of most writers on this subject, it may be said that some 60 years ago, Sir William O'Shaughnessy submitted to the Government of India the results of an enquiry which included extensive trials of Bengal clays, such as Kolgong *khári*, *Saban miti*, Rotas clays, Moulmein clays, Singapore clays, etc., as also numerous experiments in glazing the pottery turned out. (See *Appendix to Bengal Dispensatory*, pages 700—17.)

Black Salt. (*Kála-nun*)—Is an article of some importance in the local markets of India. It is prepared in Upper India, chiefly at Bhiwání in Hissár. Common salt is heated with the chebulic and emblic myrobalans together with *sají*, until a sort of fusion takes place. The article so manufactured is used as a medicine.

Phuli.—This is believed to be a form of carbonate of soda. It is imported into Leh from Changthan, Rupshu and Nubra in Ladákh. It is said to be extensively used for mixing with tea to bring out its strength. It is exported to Kashmir and Kúlu and into Lower India. The Bhotyas are said to use it for washing clothes and for dyeing wool. The average imports appear to be from 50 to 120 tons and the average cost about Rs. 6-4-0 per maund.

(b) **Barilla or Sají-khár.**—(*Dict. Econ. Prod.*, Vol. I., 394—9).—A century ago the manufacture of carbonate of soda from the ashes of certain saltworts was an important industry. Attention was accordingly early directed to India as a source of supply for Great Britain to supplement that obtained from Spain. Roxburgh, Royle, Baden Powell and many other writers in succession, described the existing trade and discussed its possible developments. Roxburgh (*Flora Indica*, Vol. II., page 61), practically speaks of the future of the Indian barilla trade as being of national importance. He explains that one species of *Salicornia*, one of *Arthrocnemum* and one of *Salsola*, which are extremely abundant plants on the Coromandel Coast, might be made to yield barilla sufficient to make soap

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and glass for the whole world, since labour is cheap and population abundant. That opinion was written before the date (1791—93) of the famine that removed fully half the labouring classes of Coromandel. It need hardly be said, however, that the discovery of Le Blanc's method of preparing sodium carbonate chemically from common salt, not only destroyed these and all other similar expectations of a remunerative trade in barilla, but revolutionized the world's necessities and demands for the salt. At the present moment, were not only the available lands of Coromandel but of all similar suitable tracts in India, to be devoted to the production of barilla, they very possibly could not supply a tithe of the world's present requirements for carbonate of soda.	BARILLA. The World's Supply. Expectations. Falsified.
But Roxburgh's further statements regarding the kindred subject, namely, the production of pearl-ash, are even more amusing and interesting. I shall quote his own words. "Our extensive, and I may also say impenetrable forests, which cover such large tracts of the best lands in India, might by degrees be cleared, and turned to potash, for the same reasons, and by the same means" as the salt-worts of the coast might yield barilla. "Certainly, labour is as cheap here as in Russia." "In this hot climate we have many advantages, viz., immense tracts of wood of the most solid texture which requires little labour to prepare it for the fire, on account of the great drought and heat which prevail at the season this manufacture could be best carried on. The same heat and drought is fully sufficient to evaporate the ley without the least assistance of fire." "Our extensive and impenetrable forests" sounds remarkable when it is borne in mind that one of the reasons assigned at the present day for the recent expansion of the area of carbonate of soda impregnated sterile soils, is the absence of forest. We know as a matter of trade history that India never actually burned her forests in the production of pearl-ash. Moreover Roxburgh's "impenetrable forests" had very possibly no reference to Northern India. Still his remarks are significant since he was one of the best informed and most careful observers and at the same time most accurate writers who ever lived in India. His words cannot, therefore, be placed on one side as unworthy of consideration. They doubtless denote that 100 years ago forest was very much more plentiful than at the present day and was possibly ruthlessly destroyed to make room for temporary cultivation.	Pearl-ashes. Impenetrable Forests. Destruction of Forests.
Royle (<i>Productive Resources of India, published 1840</i>) concludes his account of barilla with the statement that Dr. Helenus Scott had obtained the gold medal of the Society of Arts for sending from Bombay a substitute for barilla, viz., "a considerable quantity of mineral alkali, which he describes as being dug out of the ground." Now one would have expected, in a work devoted to the Productive	Early Mention of Mineral Alkali.

ALKALIS.

Alalkis, Alkaline Earths, Alkaline Ashes, etc.

BARILLA.

Was Reh a
Serious
Question in
1840?

Punjab
Barilla.

Season of
Cutting.

Description
of process.

Khar Saji
and lota
Saji.

Season of
Collection.

Revenue.

Resources of India, that the existence of *úsar* tracts, highly charged with carbonate of soda (had they existed to the same extent as they do at the present day) would have engaged Royle's attention and been the theme of a special chapter—the more so since he was for some time resident in Saháranpur. But Royle neither alludes to the destruction of agricultural lands, effected by *reh* efflorescence, nor suggests the possibility of the accumulation of salts on the surface of the ground being utilized as a source of alkali for the industries of the country. In fact he only incidentally (and as if a great curiosity) refers to Dr. Scott's discovery of "*Mineral Alkali*."

Baden Powell (*Panjáb Products*, Vol. I., 86, published 1868) gives a more instructive account of the barilla industry of that province. Very little of importance has been since written on this subject and the following abstract may, therefore, be given from that work:—The process by which this substance is prepared is carried on during the month of October and three following months. The plant after being cut down is allowed to dry. The next step is to dig a pit of a hemispherical shape, about 6 feet in circumference and 3 feet deep. One or more vessels with holes perforated are inverted and placed in the bottom of the pit, the holes being kept closed until the alkali begins to flow when they are opened by a stick previously arranged for that purpose. The dry plants are gradually burnt, and during the process a liquid substance is found to run down into the inverted vessels. After this has taken place, the residue is stirred up by means of a flat piece of wood and kept covered over for three or four days till it cools. Care must be taken not to allow water to get to the molten liquid, otherwise the whole mass would blow up. In the inverted vessels will be found a pure form of *khar saji* (sometimes called *lota* (pot) *saji*) and in the bottom of the pit an impure form containing a mixture of ashes.

In the *Dictionary of Economic Products* more recent papers are reviewed. The Deputy Commissioner of Multán says that in that district the plants are collected in January and February. He then observes that the land on which barilla-yielding plants grow was in 1883-1884 leased for Rs 7,907. The Settlement Report of Shahpur District contains an interesting account of the barilla industry in which it is stated that the farming of the monopoly fetches upwards of Rs 8,000 a year. The quantity of *saji* manufactured is said to be about 10,000 maunds. In Montgomery and Jhang the *khár* (or *khangán khár*) plant is *Haloxylon recurvum* and this is supposed to yield the finest quality of *saji* the inferior qualities are said to be made from the various species of *laná* of which the *gorá laná* is the best (*Salsola foetida*).

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Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)		ALKALIS.
In Sind the plant that yields the best <i>sají</i> is said to be known as <i>laní</i>. This grows wild all over the province and springs up spontaneously after a copious fall of rain. The process of manufacture pursued in Sind differs from that described in connection with the Panjáb in the circumstance that earthen pots (<i>lota</i>) are not employed. A piece of ground is flattened and a pit dug of a size proportioned to the extent of the contemplated manufacture—perhaps from $1\frac{1}{2}$ to 3 feet in diameter and a foot in depth. On the margin of this pit or all round about it, a fire is kindled and on this the dried <i>laní</i> plant is thrown continuously. The alkali flows into the pit and when the burning has been completed, the alkali is stirred with a stick for some hours, then left to cool and dry when it is ready for use. This industry flourishes most at Kutchí in Khelát where over 5,000 maunds are annually prepared. In Shikárpur a like quantity is made and in Thar and Párkar about 3,000 maunds are annually turned out. There seems also to exist a fairly extensive manufacture of carbonate of soda at Aden from the so-called <i>ADEN BALSAM</i> (? <i>Succeda nudiflora</i>). The publication of the article <i>barilla</i> (in the first volume of the <i>Dictionary of Economic Products</i>) led to a fairly extensive correspondence on the subject of a possible extension of the industry. In 1888 the Madras Government asked the assistance of the Director of Agriculture in the Punjab. The result was that Mr. J. R. Drummond, then Deputy Commissioner of Karnái, was invited to draw up a report on the Panjáb saltworts actually in use in the manufacture of <i>barilla</i>, and this was furnished to the Madras Government. After considering the information procured from various sources, the conclusions arrived at by that Government may be put thus:— (1) It was cheaper and more convenient to obtain sodium carbonate from alkali deposits in the soil (such as the well-known <i>dhobis'</i> earths of various parts of the Presidency) than to burn saltworts and manufacture <i>barilla</i>; (2) the imported pure salt could be had at such a low price that it was doubtful whether either methods were likely in the future to compete successfully. (c) Indian Saltworts.—The following may be given (in continuation of pages 123, 124) as an alphabetical enumeration of the better known saltworts of India, in which all those that might be successfully tried in reclamation of <i>reh</i> efflorescence have been shown as well as those actually employed in the manufacture of <i>barilla</i>.	BARILLA. Sind Barilla. Description of process. Extent of Trade. Aden Barilla. Madras Trade. Madras Opinion. Saltworts. List of Chief Plants.	

ALKALIS.	<i>Alkalis, Alkaline Earths, Alkaline Ashes, etc.</i>
INDIAN SALT-WORTS.	<i>Arthrocnemum indicum</i>, Moq. (<i>Dict. Econ. Prod.</i>, Vol. I., page 328). (Syn. <i>Salicornia indica</i>, Willd., as in Roxburgh's <i>Flora Indica</i>, Vol. I., page 85; the <i>Jadu palang</i> of Bengali; <i>Machola</i>, <i>machur</i>, <i>ghuri</i>, <i>chil</i>, of Western India; the <i>Umari</i> of Tamil; and <i>Koia-pipali</i> or <i>koya-pipili</i> of Telegu.) This is one of the four plants of the Coromandel coast recommended by Roxburgh, in the passage quoted above for the production of barilla. It is a native of the salt marshes of Bengal, Madras, and Bombay.
Coromandel Plants.	<i>Atriplex repens</i>, Roth, (<i>Dict. Econ. Prod.</i>, Vol. I., pages 349-51). (Syn. <i>Obione Koenigii</i>, Moq. <i>Wight Ic. t. 1790.</i>) A shrubby plant found on the coast of South India (Tuticorin) and of the Deccan Peninsula. Referred to in official correspondence as having been experimented with unsuccessfully in Madras as a source of barilla.
Deccan Plant	<i>Atriplex Stocksii</i>, Boiss. (Syn. <i>A. Griffithii</i>, var. <i>Stocksii</i>, Boiss. <i>A. repens</i>, Aitchison, <i>Cat. Pl. Pb.</i>) A shrubby species common in the salt marshes at Karachi, and fairly frequent in Guzerat where it is known as <i>Juri</i>.
True Barilla. Plant.	<i>Halocharis violacea</i>, Bunge. A small diffuse prostrate annual common in the Peshawar valley, the Western Punjab, the Salt Range and Baluchistan. Might be useful on alkali soils. <i>Haloxylon recurvum</i>, Bunge, (<i>Dict. Econ. Prod.</i>, Vol. IV., page 199). (Syn. <i>Salsola lana</i>, Stocks, and <i>Caroxylon Griffithii</i> of <i>Dict. Econ. Prod.</i>, Vol. I., page 399; it is <i>khár</i> or <i>laghme</i> of the Punjab and <i>khári-laní</i> of Sind.) A straggling bush met with plentifully in the Central and Western Punjab plains and Salt Range but occurs also in Sind, the Deccan Peninsula (Coimbatore) and in Burma. It is the most important barilla yielding species and according to Drummond is most abundant in Jhang and in the "Bar" tract generally.
Barilla Substitutes.	<i>Haloxylon multiflorum</i>, Bunge. <i>H. salicornicum</i>, Bunge. These two shrubs appear sometimes to be used in place of or as an adulterant for No. 5 above. The former occurs in the Punjab and the latter in Sind. <i>Koehla indiea</i>, Wight, (<i>Dict. Econ. Prod.</i>, Vol. IV., page 567). The herbaceous plant occurs from Delhi to the Indus also in the Deccan Peninsula on salt soils (Coimbatore). It is in the Punjab known as <i>Bui</i> or <i>kauro ro</i>.

Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)	ALKALIS.
Salicornia brachiata, Roxb. ; (<i>Dict. Econ. Prod.</i>, Vol. I., page 387). This small shrub is found on most salt marshes (in Bengal, South India (Tanjore), &c.). It is one of the plants specially recommended for experiment by Roxburgh. He says that it is found plentiful on low wet ground overflowed by the spring tides. He gives it the Telegu name of <i>Quoilu</i> or <i>koyalu</i> and in Tamil <i>Umarí-kírai</i>.	INDIAN SALT-WORTS. Recom- mended for Trial.
Salsola foetida, Del. ; (<i>Dict. Econ. Prod.</i>, Vol. VI., Pt. II., page 392). A large shrub plentiful in the Central and Southern Punjab or from Delhi westward to Sind and Baluchistan. It is the <i>Laná, móti láne, gorá lána</i>, or <i>laná góra</i> of the Punjab ; <i>Shora</i> or <i>shorga</i> of Pushtu ; <i>Lanan</i> of Sind and <i>Ella-kura</i> of Telugu. It is a saltwort much valued as a fodder for camels and sometimes employed in the manufacture of barilla, especially in the Hari-rud, where it is used in the preparation of <i>khár</i> or <i>ishkhár</i>, as it is there called.	Chief Substitute for the Khar Plant.
Salsola verrucosa, M. Bieb. A stout hoary shrub or tree met with in the Punjab from the Peshawar valley South-Westwards.	
Suaeda fruticosa, Forsk., (<i>Dict. Econ. Prod.</i>, Vol. VI., Pt. III., page 386).	
(Syn. Salsola indica, Wall., S. lana, Edgew.) This is the <i>Lunak, choti-laní, usák laní, khár-khusa, baggi-lana</i> or <i>dana</i> of the Punjab. It is also the <i>Limch</i> of Pushtu ; and <i>Ushak laní</i> of Sind. It is a sub-erect shrub met with in North-Western India from Delhi throughout the Punjab to Sind. This is used mainly as an adulterant in the manufacture of barilla.	Adulteration of Barilla.
Suaeda monoica, Forsk. A shrubby species met with on the sea coast in the South Deccan (Tuticorin).	
Suaeda nudiflora Moq., (<i>Dict. Econ. Prod.</i>, Vol. IV., Pt. III., page 386).	
A shrub met with on the coast of Bengal, Bombay and South India. This is <i>Morasa, moras</i> of the Mahratta ; the <i>Khávi-laní</i> of Sind ; the <i>Geria</i> of Orissa ; and the <i>Kiray</i> of Tamil ; and <i>Rava kada</i> or <i>reyi kada</i> of Telegu.	
Suaeda maritima, Dumort., <i>Dict. Econ. Pro.</i>, Vol. VI., Pt., III., page 386).	
A herbaceous species occasionally becoming shrubby, met with in the Upper Gangetic Plains from Delhi to the sea coast of Bengal, Bombay and the Deccan, on salt impregnated soils. The leaves are universally eaten, specially during times of famine (Roxburgh). According to Drummond most of the references by authors to Suaeda nudiflora	A Useful Vegetable.

ALKALIS.

Alkalis, Alkaline Earths, Alkaline Ashes, etc.

BORAX.

should in reality be taken to denote this plant. It is the *Laní* of the Punjab ; the *Khári laní* of Sind ; the *Laná* of Mahratta ; the *Yella kiray* of Tamil ; and the *Ila* or *Ella-kura* of Telegu.

Vernacular Names.

(B) BORAX OR SODIUM BI-BORATE.—*Dict. of Econ. Prod., Vol. I., pages 504-11.* ; The Mineral Industry, 1900, pp. 57-59. This salt is known in India under an extensive series of vernacular names such as *Sohágá tinkál*, *kuddia khár*, *tankankhár*, *venkaram*, *velligaram*, *billigárá*, *lakhiya*, *vavut*, etc. It is known in Sanskrit as *Tan-kana* and in Persian as *Tinkar* or *tankar*. In some parts of the Punjab frontier and Tibet it is known as *tsalé* or *sal* (*shal*) (one variety being *chú tsalé* or water-borax, the other *tsalé mentog* or flower-borax.)

Early Mentions.

History.—This substance was known to the ancient Sanskrit authors and is mentioned by **Susruta**. From the Sanskrit is derived doubtless its Persian and most of its Indian vernacular names as also its old English synonym **TINCAL**. Perhaps the earliest mention (by a European writer) of this substance, in connection with India, is the reference by **Garcia de Orta** (in 1563) in which he says it is known to the Guzeratis by its Arabic name of *tincar*. It is mentioned by **Abul Fazl** in the *Aini-Akbari* (1590) and is called *tangar*. **Hove** (a Polish savant who visited India in 1787) describes the salt as refined in *Káthiáwár*. **Ainslie** (*Materia Indica*, published 1826) gives a good account of it as a drug and says that the process by which **TINCAL** was refined into borax, was kept a secret by the Dutch. **Royle** (*Productive Resources of India*) gives a brief notice of the substance, but by far the most complete statement hitherto published may be said to be that given by **Baden Powell** in his *Panjab Products* (published, 1868). This reviewed the reports of **Cunningham**, **Hay**, **Edgeworth**, **Marcadieu** and others. **Ball's Economic Geology** brings the Indian literature to the date of 1881 since which time little of importance has been ascertained except that the foreign exports from India have dwindled to insignificance.

Decline of Indian exports.

Sources.

Indian Area.

Sources.—Borax proper is a native borate of sodium found, along with common salt, on the shores of certain lakes in the Panjáb and North-West Tibetan Frontiers and within Tibet itself, and possibly beyond in Persia and China. The Indian area may thus be said to commence in Puga valley of Ladákh and to pass East to the lakes of Rudokh. To the South of Lasha, at the Yamdok-cho, borax is also obtained. Holes are dug in the ground in many parts of the deserts of Tartary and within these tincal is said to collect.

Trade Routes.

The Western supply (*viz.*, from Puga) enters India by Kúlu and is refined at Sultánpur before being consigned, *viâ* Mandi and

Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)

ALKALIS.

Bhaji to Simla or *via* Rámpur in Bashahr to Jagádhri and thence to the plains. Smaller quantities from this same source also find their way through Chamba to Núrpur or to Kashmir and Lahore. Tibetan borax enters India across the frontier of the United Provinces. Atkinson furnishes an interesting account of this traffic. The borax he says is collected in June to September and sold at certain markets. It is brought by Bhotiya traders and purchased by the merchants at Rámnagar where it is refined.

Economic and Industrial Uses.—Borax is used extensively as a mordant in dyeing and calico-printing. Medicinally it is viewed as a tonic, useful in loss of appetite and painful dyspepsia, and also as an exceedingly valuable detergent in affections of the skin. The antiseptic and disinfecting property of borax, although fully known, might, as it seems, be much more extensively taken advantage of than appears to be the case. For household purposes, its uses are practically limitless. As a substitute for soap and soda crystals, it may be said to clean without destroying colour. As a preservative for meat, it is invaluable and it is probable that as an insecticide (especially in the tea garden) it would be found unrivalled. Its most important use may be said, however, to be for glazing pottery and as a simple and convenient enamel for metallic surfaces, such as the dials of watches and clocks or domestic enamelled metal wares. It acts as a flux in the formation of a glass which has a low melting point and thus affords a material that may be employed even in the ornamentation of the surface of glass or glass vessels, since it can be fused and fixed at a temperature lower than what would re-melt the glass on which it has been painted. But ornamentations produced by borax glass are generally held to be unstable, because of the fact that borax is rendered anhydrous by fusion, but in time gradually absorbs moisture and becomes hydrated and efflorescent, when the glaze made of it splits and crumbles to pieces. Sir William O'Shaughnessy was instructed by the Government of India (in 1839) to investigate the question of the production in India of glazed pottery sufficient for use at Indian hospitals. His report will be found in the appendix to the *Bengal Dispensatory*, and on pages 710 and 711 he gives a most instructive description of the lime-borate that he employed.

BORAX.

Refined
Borax.Industrial
Uses.
Mordant.
Medicine.Antiseptic.
Detergent.

Insecticide.

Glazing
Material.Glazed
Pottery.Metal
Welding.

Glass Beads.

Precious
Stones.

Borax may be said to be invaluable in welding and is employed by blacksmiths, brass-founders, and electroplaters. It is largely consumed in the manufacture of glass beads, imitation precious stones, certain qualities of glass and descriptions of cements. It is in fact fairly extensively utilized by the Indian jewellers in the manufacture of artificial gems and with shellac it forms a most

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BORAX.
Varnish.
Soldering.

Soap.
Cosmetic

Candle
Wicks.

TRADE,

Foreign
Exports.

Transfrontier
Imports.

CAUSTIC.

Paper Mills.

Electric
Separation.

valuable varnish. In soldering oxidisable metals its action is to clean the surface by fusing away the oxides into a borax bead. Similarly it is employed by the Indian jewellers to cleanse gold and silver ornaments. Plumbago pots are found to last very much better if after being annealed in the oven they are painted with a solution of borax. Lastly borax is employed as an ingredient in certain toilet soaps and cosmetics and one of its most curious and interesting uses is that of its employment in the production of a self-trimming wick in candles. For this purpose the wick is saturated with borax, then made into a candle. When ignited an incandescent bead is formed that greatly improves the light-giving property of the flame, while at the same time the wick, being weighted by the bead, turns over to one side and thus protudes sideways out of the flame. In that position it is readily oxidised and passes away as carbonic acid—thus dispensing with the necessity of snuffers.

Trade.—For some years past the foreign demand for Indian borax has been steadily declining, in consequence of the Italian manufacture from boracic acid and sodium carbonate, as also in consequence of the discovery in California and Nevada of limitless supplies. So recently as 1886-87, the foreign exports of borax were 24,273 cwts., valued at ₹5,80,637. During the past five years they have shown an average of 4,300 cwts., valued at about ₹85,000. The internal consumption has not, however, declined materially. In 1897-98, the imports across the land frontier to India were 15,273 cwts.; in 1898-1899, 16,564 cwts.; in 1899-1900, 20,315 cwts.; in 1900-1901, 18,621 cwts., and in 1901-1902 they were 31,085 cwts. valued at ₹3,61,446. It will thus be seen that borax is an article of considerable importance in the industries of this country and it is satisfactory to know that the local supplies have proved sufficient to check materially imports from Europe or America.

(C) **CAUSTIC SODA.**—(=*Ksharā* in Sanskrit).—So much space having been devoted to carbonate of soda and to Sodium bi-borate, the present salt must be disposed of in the briefest possible manner. At the present day it may be said that India's supply comes entirely from foreign countries. One of the Indian paper-mills is believed, however, to have attempted the preparation of its own supplies from the *réh* salts found in the neighbourhood but it is not known whether its endeavours in that direction were successful.

The greatest possible interest has been aroused in Europe and America, through the discovery of a method of direct decomposition of common salt into caustic soda and chlorine gas, by means of electricity. With regard to Electro-Chemistry the reader might consult *The Mineral Industry* for 1900, (*New York*), pages 763—772.

Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)

ALKALIS.

CAUSTIC
SODA.

Alkali Works.

The Indian press have hailed the discovery of the direct decomposition of salt as bringing a cheap supply of alkali to the doors of our Indian soap works, paper-works, etc., owing to India possessing a limitless supply of sodium chloride. The great recommendation to India of this new method lies in the fact that sulphuric acid is not required. Without sulphuric acid Le Blanc's manufacture of soda-ash could not be brought to bear on our supplies of common salt or of *réh* efflorescence—hence in all probability, the backwardness of India in chemical enterprise. But it must not be forgotten that India's total demand for alkalies could not at present support chemical works on a scale of magnitude to admit of their under-selling the chemical works of Europe, even while these are burdened with heavy freight charges and import duties.

(D) **COMMON SALT OR SODIUM CHLORIDE.**—Subject too large to be dealt with here.

(E) **GLAUBER'S SALT OR SODIUM SULPHATE.**—This is generally known in India under the name *Khari* or *Kharinun* and as already explained (page 117 *et. seq.*) it is met with as one of the efflorescent salts that constitute *Réh*. It has been shown (page 125) that the chief use of this salt might be regarded as the preparation of carbonate of soda. Its production is, at all events, the first stage in the Le Blanc process of soda manufacture and where met with at all abundantly as a surface efflorescence it might be viewed as first stage of the Le Blanc process accomplished without the expense of sulphuric acid having been incurred.

Preparation.

This is in India derived from *réh* efflorescence, either by solar evaporation (*abi*) or by artificial heat (*jaria*) and by a method very similar to that pursued with crude saltpetre. The quality of the earth collected is of course different in each case but the nature of the filters, boilers and pans employed is the same; and for evaporation and condensation of the brine, boilers and *chunam* pans are both used, the former in Behár and the latter in the United Provinces of Agra and Oudh, where prolonged dry hot weather may be more confidently reckoned on than in Behár. *Patna-khari*, as the *khari* produced in Behár is called, is used chiefly for preserving hides, and also as a cathartic for cattle; it sells at from 8 to 12 annas a maund. It contains very little sodic chloride. *Khari* produced up-country by solar evaporation is much used as a cathartic for cattle. It contains a considerable percentage of common salt (20 to 30, and sometimes even more), and realises fm 12 annas to one rupee per maund.

Patna-Khari.

Uses.

Industrial Uses.—The chief economic use of Glauber's salt may be said to be (as already remarked) the curing of hides for

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ALKALIS.

*Alkalis, Alkaline Earths, Alkaline Ashes, etc.*GLAUBER'S
SALT.

which purpose it is better suited than common salt, owing to the tendency of the latter to absorb water and soften the hides. The *khari* (or *chamra-khari*) of Behár being, as a rule, purer than that of the United Provinces is in greater demand. Dr. Buchanan Hamilton in 1809 drew attention to this circumstance by his having pointed out that the *Patna-khari* was the best procurable in India. According to U. C. Dutt this was known to the recent Sanskrit writers under the name of *Kshári lavana* and was used medicinally in combination with other saline substances. As manufactured in India it is an impure salt but may be employed as a medicine for horses and cattle.

Medicine.

ALKALINE
EARTHS.
(Conf. with
Alkalis.)

ALKALINE EARTHS.—Having now discussed the true alkalis and their salts with as much detail as the available space will admit of, it becomes necessary to record the chief facts known regarding the *Alkaline Earths* and their salts as met with in India.

BARYTA.

4. **BARIUM and BARYTA.**—The oxide of this metal (baryta) isCarbonate of
Barum.

an extremely caustic, poisonous and strongly alkaline substance that forms a hydrate with water. (A) **Barium Carbonate.**—This is imported into India to a very limited extent. It is highly poisonous. In Europe it is employed as an ingredient in certain forms of pottery and glass-ware and is the basis of certain delicate colours. In France it is used in the defecation of beet root sugar in place of lime. (Conf. *The Mineral Industry*, 1900, pages 53-54.)

Used in
Pottery.Defecation of
Beet-sugar.

(B) **Barium Nitrate.**—This is obtained by decomposing the carbonate by means of nitric acid. It is the chief salt employed in pyrotechny for the production of green fires. It is also the tinctorial principle in **BARYTA GREEN**—a pigment of some value. Recently barium nitrate has been substituted for saltpetre in the preparation of certain explosives. (C) **Barium Sulphate.**—This is the most important of the barium salts and is known as **BARITES (BARYTES) or HEAVY-SPAR.** It is found in mineral lodes and usually constitutes a distinct portion of the gangue there present. In the Karnúl District, Madras, it occurs along with galena, within veins of quartz. If ever worked large supplies could be obtained from that locality. So in the same way barytes exists in the Central Provinces in association with copper such as at Jabalpur and in the Rewá State. In Rájputána barytes has been reported by Dr. Irvine as occurring at the lead mines of Taragarh in Ajmir. In the Panjáb it has also been found in association with galena at Subáthu in the Simla District. While it would thus appear that the Indian sources of this alkaline earth have not been worked, barium sulphate is nevertheless available in every bazar and seems to be very largely sold as “white lead” or in adulteration of that

Nitrate of
Barium.
Baryta Salt-
petre.Green
Flames.Baryta
Green.
Sulphate of
Barium.
Barytes.Occurrence
in India.Adulteration
with White-
lead.

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ALKALIES.

substance. The reader will find an example of the extent to which this sulphate is employed in India by consulting the account given of the Afridi Wax-cloth industry under *CARTHAMUS OXYACANTHA*. Barytes is also used by the paper-makers and to a limited extent as a cheap substitute for barium nitrate in certain forms of fireworks.

5. CALCIUM and LIME.—*LIME* does not exist naturally, but in the form of the carbonate, it constitutes a by no means insignificant portion of the earth's crust, *e.g.*, limestone rocks. *LIME-BURNING* is the operation of driving off carbonic acid from the carbonate with the production of the oxide of calcium or *QUICKLIME*. This readily absorbs water and becomes *SLAKED LIME* or hydrate of lime.

Carbonate of Lime; (*Dict. Econ. Prod.*, Vol. II., 142-152, V., 185-86). This is known in India by an extensive series of names that denote both the conditions (quicklime, slaked-lime, etc.), and the source (limestone, marble, chalk, shells, etc.). The most general name may be said to be the Hindustani *Chúnd* a word which in the various languages of India assumes numerous forms such as *Churna*, *chúnáh*, *chún*, *chúno*, *chúnak*, *chúnámbu*, *shunnambu*, *sunnam*, *sunna*, *hunna*, *hunu*, etc. Its most general name in Sanskrit would appear to be *Sankha bhasma*, but certain writers give also *chúrúd*, (=a "powder"), *sudha kapardaka-bhasma*, *sukti-bhasma*, etc. Its Arabic names appear to be *Kils* and *ahu* and its Persian *Nurkah* and *ahak*.

The word *chúnám*, by modern usage generally denotes the beautiful plaster or cement characteristic of many localities of India (more especially of South India); see below in the paragraph devoted to cements. One of the earliest European writers to use the word *chúna* appears to have been Garcia de Orta (A. D. 1563), although fifty years previously the Italian Traveller Varthema described the people around Calicut as eating betel leaves along with a certain lime made from oyster shells which they call "Cionama."

CHALK is very generally known as *Khari-matti* or *kharya-mitti*. Unslaked or quicklime is *Kali-ka-chuna* or simply *kali* or *kalai*; limestone is *Kalai-ka-pattar*; quicklime is often called *Ahak*; lime from shells is *Sipi-ka-chuna*, the lime from limestone being *Kattal-ka-chuna*; marble is *Marmar*; fossil corals are *Sang-i-yahada*.

Sources.—There may in India be said to be three great groups of rocks or materials that afford lime; (a) limestone or marble; (b) concretionary lime (*Kankar*) found in the ground; (c) Marine and Land Shells; also coral reefs.

BARYTA.
Conf. Agri-
cultural
Ledger No. 12
of 1901.

Used by the
Paper-
makers.

LIME.

Lime
burning.
Quicklime.
Slaked lime.

Carbonate.

Vernacular
Names.

Chunam.

Edible Lime.

Chalk.

Sources.

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ALKALIS.

*Alkalis, Alkaline Earths, Alkaline Ashes, etc.*LIMESTONE
AND MARBLE.Best known,
Marbles.

Makrána.

(a) **Limestone, Dolomite and Marble.**—It may be said that hardly any known geological formation in India is wholly without limestone in some form, although many of the examples are exceedingly impure and hardly worthy of the name. The best known marbles are those of Jodhpur (Makrána) and of Jaipur (Raialo), in Rájputána and of Jabulpur, in the Central Provinces. Within a radius of eight miles around Makrana there are something like one hundred quarries but of those only 15 are at present worked. These vary in depth from 30 to 75 feet and follow the vein. The marble is excavated by blasting, and is then cut into the required size by steel saws. It is hauled to the surface on wooden rollers and manual labour. The quality of the stone is generally better according to the depth it is worked but owing to the crude appliances used for hoisting to the surface, deep mines are impossible. The dust and fragments produced during mining operations at Makrana are burnt into lime and this quality is much appreciated for the finer kinds of plastering.

Raialo.

The white marbles of Raialo are much appreciated for filagree screens (*jálí*) of which numerous fine examples exist at Abu, Agra, Ahmadábád, Delhi, etc. The black marble found at Bainslana is used for statues, toys, etc. The blue and pink marbles of Narwár in Kishengarh State are much admired and largely used for ornamental purposes.

Jabalpur.

Ball, in his *Economic Geology*, has the following passage regarding Jabalpur marble:—"Except locally, in some temples, this marble has not been used for building purposes. The beds are much jointed and crushed by the disturbance, which has tilted them into their present vertical position and by certain trap dykes which traverse them. But it seems probable large unflawed blocks might be obtained; one which was sent to the first Paris Exhibition was said to be equal to Italian marble for statuary purposes."

Burma.

Marbles for
Idols.

In Burma there is an inexhaustible supply of lime such as limestone, raised coral reefs and marble. The beautiful semi-transparent white marble so extensively used for the figures of Gautama is obtained chiefly from the Tsygen hills in the Madeya sub-division of the Mandalay district.

Inferior
Marbles.

Building

Space cannot be afforded to refer more than by name to a few of the other numerous qualities of limestone and marble met with in India. Some are of nearly equal merit to those already specialised and still others gradually decline until they have to be characterised as at most only good building limestones. The limestones procurable

<i>Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)</i>	ALKALIS.
in many parts of Bombay and Sind, for example, are admirable building stones though marble nowhere exists. The Porbandar miliolite and the great sandstones of Dhangadra are perhaps the best known. The former has been conveyed from Káthiáwár to Bombay and even to Calcutta and is employed in the construction of some of the more important of the recent buildings of these cities. In South India it may be said that crystalline limestones occur in Trichinopoly and Coimbatore, but of very inferior quality; good building limestones are found in Cuddapah, Karnúl and Guntúr, and marbles at Palnad. In the Central Provinces there are numerous examples of limestones and admirable building stones, such as those of Wardha, Nágpur, of the Vindhyan formation such as the limestones of Katni, and in the United Provinces the crystalline limestone of Mirzápur, which occur in the metamorphic rocks of that district. In various localities of the Panjáb good limestones and even marbles are found. Lastly a reference is essential to the limestones of Lakhimpur and of the Khásia and Jaintia Hills of Assam.	LIMESTONE AND MARBLE. Porbandar Miliolite. Katni, Mirzapur. Assam.
This brief indication of some of the more important marbles and limestones of India may now be fittingly concluded by the following passage contributed originally to the <i>Diet. of Economic Products</i> by Mr. H. B. Medlicott:—	Sources of Lime.
“Lime is a scarce article in many parts of India. Much of the lime used in Calcutta is carried many hundred miles by river and railway. The want of a pure limestone flux at moderate cost has been the chief difficulty in working the iron furnaces in the Raniganj coal field. The most general source of building lime in India is <i>kankar</i> or <i>kunkur</i> (meaning gravel), a granular or nodular stone found on the surface and in the sub-soil. It is purely of secondary origin, being formed on the spot by the evaporation of the groundwater, containing in solution more or less of carbonate of lime produced in the slow process of soil formation by the general decomposition of rock-particles. The production of it is very much a matter of climate, by alternating period of soaking moisture and extreme dryness. Where this latter condition is most pronounced, as in North-Western India, the lumps of <i>kankar</i> often coalesce into a continuous mass, fit for use as building stone. A stone so formed must of course be impure and variable in quality, as to the quantity and nature of foreign matter according to the texture and composition of the bed in which the concentration of the lime is effected, but when these are favourable an excellent hydraulic lime is the result.	Formation of Kankar.
“Limestone is, however, of widespread occurrence throughout British India, but as a rule the available deposits are at a distance from the	Limestones.

ALKALIS.

Alkalis, Alkaline Earths, Alkaline Ashes, etc.

LIMESTONE
AND MARBLE.

centres of demand, and consequently the price of lime rules high. The most important sources, commercially, are :—

“ 1st. *Katni*.—in the Jabulpur District ; supplies a lime of excellent quality, which is carried as far as Calcutta (737 miles distant), and forms a large proportion of the lime used in that city.

“ 2nd. *Sylhet*.—Along the southern foot of the Sylhet hills there is an inexhaustible supply of lime in the limestone of the nummulitic series, which formerly supplied the whole of the demand of Calcutta and Lower Bengal, and still does so to a large extent.

“ 3rd. *Rhotasgarh*.—The lower Vindhyan limestone near Rhotasgarh is quarried to a small extent and exported down the Són in boats ; it was largely used in the works of the Són Canal.

“ 4th. *Himalayas*.—Along the foot of the Himalayas, boulders of limestone are collected and burnt in large quantities every year ; the slaked lime is exported on camels, and supplies a large portion of the Punjab, and the North-Western Provinces.

“ 5th. *Andamans*.—There is a band of cream-coloured marble near Port Blair which may prove of economic importance, as it is at about the same distance from Calcutta as Katni, and the lime is of equally good quality.

“ 6th. *Other Localities* where limestone is known are numerous, but at present of merely local importance, or in most cases of no value whatever. A full list of them as far as they are known, will be found in the *Manual of the Geology of India*, Vol. III., p., 449, *et. seq.*”

KANKAR.

Position of
Kankar.

(b) **Kankar or Concretionary Lime.**—In the passage just quoted Medlicott has explained the formation of this substance. In the vast majority of cases a layer of *kankar* will be found to underlie *úsar* soils. This circumstance has purposely not been alluded to in the passage that deals with *réh* efflorescence because, although doubtless formed by the same physical forces, *réh* and lime have not been shown to be dependent on each other. *Réh* efflorescence may occur without any formation of *kankar* and conversely *kankar* may exist within the soil without any evidence of *réh* efflorescence or even of an abnormal deposition of soluble alkalis, see page 119.

Uses.

Hydraulic
Lime.

This is the chief source of lime in Upper India and it yields an excellent and somewhat hydraulic lime. Mr. James Cleghorn (*Indian and Eastern Engineer*, June 1898, pages 356-57) gives the results of his study of this substance and of its practical utilisation as mortar. Very often the nodules of *kankar* are so abundant, at certain depths below the surface of the ground, that they become consolidated into block. Such blocks when obtainable are largely employed for building purposes and were so used extensively in the

Block
Kankar.

Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)

ALKALIS.

KANKAR.

Road-making.

Flux for
Iron.

SHELL LIME.

USES OF
LIME.

Plant Food.

Manure.
Deodorising
Agent.Bleaching
Powder.Calico-print-
ing.Lime with
indigo.

Paint.

Afridi Wax-
cloth.
Tanning.

Ganges Canal Works. *Kankar*, broken and hammered while water is poured over, is the material mainly used for road-making in the greater part of India. This circumstance gives at once a vivid conception of the abundance and extensive distribution of the substance. *Kankar* has been tried as a flux for iron on several occasions, but with very indifferent results. Its composition is too uncertain and its liability to adulteration too great to admit of its use, except where limestones are not available.

(c) **Shell and Coral Lime.**—All over India shells are burned for lime. Away in the interior of the country wherever annual inundation occurs, a marvellous crop of exceptionally large land shells furnishes an abundant supply for most local necessities. In the Murshidábád District for example the following shells are so employed:—*Unio marginalis*, *U. flavidens* and *Ampularia globosa*. On the coast tracts of India and Burma, immense beds of marine shells and of raised coral reefs are met with. These are regularly utilised as sources of lime, and in South India have mainly given birth to the prosperous industry of Portland Cement manufacture—an industry that I understand is likely to be very shortly organised near the mouth of the Ganges, where rich beds of marine shells are abundant.

Industrial Uses of Lime.—*Limestone and Marble.* Lime is universally present in the ash of all plants. As a manure it plays an important part, especially for soils rich in organic matter. For a similar reason lime is largely employed as a deodorising agent: it hastens decomposition of both animal and vegetable matter and absorbs noxious effluvia. In the form of chloride of lime (**BLEACHING POWDER**) it was at one time largely employed as a disinfectant. For that purpose it has, however, been considerably displaced by more effectual and less objectionable substances such as carbolic acid. As a bleaching re-agent chloride of lime is extensively employed, such for example as in the raising of metallic colours, in discharging Turkey reds, in calico-printing, etc. In India it is made into a resist paste with ordinary gum arabic and in that form is utilized by the calico-printers. Lime in some form is in fact extensively used in the dyeing and tanning industries. It is for example nearly universally employed by the Native manufacturers of indigo. Along with sugar it is added to the dyer's indigo vat in order to assist in the production of white-indigo. The carbonate of lime is used as an oil paint for in-door work and as a water colour mixed with gelatine. The Afridi wax-cloth workers add lime to their *roghan* to reduce its liquid condition and make it dry readily. The tanner utilizes it to remove the hair from hides. It, at the same time, also

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ALKALIS.		Alkalis, Alkaline Earths, Alkaline Ashes, etc.
USES OF LIME.		greatly improves the hides by softening their texture. Lime is of the greatest importance to both the soap and the candle makers, and it is necessary as a flux for iron smelting.
Soap and Candle making.		<i>Food and Medicine.</i> —As an article of (what might be called) food, it is largely used by the people of India. In other words it is an essential ingredient in the preparation known as <i>pán</i> . The lime obtained from shells is objected to, however, for that purpose, by certain Hindus, on the ground that it is derived from animals. For medicinal purposes, lime enjoys a well recognised position, more especially as the basis of the mild antacid known as “lime water.” It is used in the defecation of the saccharine juice obtained from beet-root. The coagulation of the nitrogenous matter, by boiling, is less perfectly accomplished in the case of beet than of cane juice. The addition of slaked lime accordingly greatly facilitates that result by the formation of insoluble lime compounds.
Pan.		<i>Mortar and Cement.</i> —(<i>Diet. Econ. Prod.</i> , II., 245).—By far the most important use of lime is as mortar—a cement which consists of lime, sand and water. If lime be mixed with water, a paste is formed that will rapidly harden or “set” as it is called. When dry it will, however, be found to crack and crumble to pieces. To prevent this it is mixed with sand (or in India with the fine powder made from bricks known as <i>surkhi</i>). To obviate a too rapid absorption of water from the mortar, it is customary to moisten the stones or bricks, when a much more durable cement is the result. If mortar be properly prepared a thin layer will be found sufficient to bind together the materials with which it is mixed.
Lime water.		
Defecation of Sugar.		
Mortar.		
CEMENTS.		There are commonly said to be the following classes of cements:—(a) CALCAREOUS ; (b) GELATINOUS ; (c) GLUTINOUS ; (d) RESINOUS ; (e) MIXED MATERIALS but Non-resinous. The first mentioned are those with which the present article is more immediately concerned such, for example, as the mortar already indicated. A hydraulic cement or Portland cement as it is called, is in other words a cement which has the property of setting under water. This is obtainable from certain limestones that naturally contain from 10 to 25 per cent. of alumina, magnesia and silica, or it may be artificially manufactured by mixing 65 to 80 parts of chalk or other pure lime, with 20 to 35 parts of river mud or clay, and a little oxide of iron, say 3—14 per cent. These ingredients are thoroughly mixed in water, dried slowly, calcined and then reduced to a powder. In India Portland cement is at present mainly manufactured in the Madras Presidency but in other Provinces it is occasionally prepared and chiefly from argillaceous <i>kankar</i> to which a certain proportion of fat limestone is added. But it is a striking peculiarity of these hydraulic
Portland Cement.		
Indian Production.		

Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)

ALKALIS.

cements that their adhesive power is diminished by mixture with sand. If used as a stucco the sand employed must be perfectly free from loam and the surface must not be painted over (if that be so desired) until the cement has been thoroughly dry say for some months.

USES OF
LIME
CEMENTS.

It may further be added that if Portland cements have more than 4 per cent. magnesia they rapidly decompose when kept under water. A cement with a basis of white magnesia in place of clay, is sometimes known as "White Mortar." There are large deposits of magnesite and of magnesium limestones (dolomites) especially near Salem) in South India and these it is understood have recently been taken advantage of by the Madras Portland Cement Company in the preparation of a cheap, easily applied and rapidly drying plaster that takes a fine polish. This I understand is being made both at Bangalore and Calicut. Mr. C. S. Middlemiss wrote in 1896 a most interesting report on the magnesite areas of the Chalk Hills near Salem. (See *The Agricultural Ledger No. 15 of 1896*.) A paper written by Mr. James Cleghorn, *Indian and Eastern Engineer, May 1894, pages 320-321*) will also be found to contain much useful information regarding magnesian cements. Regarding the industry in the United States of America consult *The Mineral Industry, 1900, pages 75-82*.

Magnesian
Cements.

Mention has already been incidentally made to the fact that an admirable polishing and exceedingly strong cement (sometimes spoken of as *chínám*) is made in various parts of India. There are methods of preparing this substance, but these all practically agree in the circumstance that some saccharine substance or other is combined with the lime. The substance most commonly employed for this purpose is the jaggery obtained from the cocoa-nut palm. The milk of that palm is also mixed with lime in the preparation of a very superior white-wash.

Polishing
Cement.

Lime or some of its salt (such as plaster of paris) is largely employed in combination with glutinous and resinous materials in the formation of cements. The gluten of rice is in India commonly mixed with a certain percentage of pure lime in the preparation of a strong cement which is employed to join the various parts of musical instrument in place of glue. Instead of rice gluten the dough of fine flour may be kneaded in water until gluten only remains. To this should then be added a small quantity of pure lime. The cement thus prepared is largely used for all forms of wood-work and has the special merit of resisting damp. It is generally known by the name *suji*. Lac combined with borax forms a convenient cement to be used where exposure to water or moisture is unavoidable. Cutlers'

Special
Cements.

Suji Cement.

Lac Cement.

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ALKALIS.

*Alkalis, Alkaline Earths, Alkaline Ashes, etc.*USES OF
LIME.
CEMENTS.
Ingredients.

cement consists of rosin, bees'-wax and brick-dust or plaster of paris, or simply rosin and plaster of paris.

Cement Materials.—The following substances are mentioned as being specially used in India in combination with lime, in the preparation of special cements :—

- | | |
|--|--|
| 1. <i>Adenanthera pavonina</i> —seeds. | 5. <i>Commiphora</i> <i>Agallocha</i> —the gum resin. |
| 2. <i>Egle Marmelos</i> —glutinous matter of wild fruits. | 6. <i>Oryza sativa</i> —the gluten of rice. |
| 3. <i>Borassus flabellifer</i> —juice. | 7. <i>Sugar</i> — <i>Gur</i> . |
| 4. <i>Cocos nucifera</i> —jaggery, (crude sugar) and also the milk of the fruit. | 8. <i>Triticum vulgare</i> —the gluten of wheat. |
| | 9. <i>Typha angustifolia</i> —the down from ripe fruits. |

For further information see *Cements* in the *Scientific American Cyclopædia of Receipts, Notes and Queries*, by Albert A. Hopkins pp. 67-90.

MARBLE
WORKS.Screens
Jali.Brahmanical
Idols.White
Marble.Black
Marble.Ornaments
and Toys.

Marble.—Is extensively employed in the decoration of palaces, temples and mosques, and in the construction of idols, ornaments, toys, etc. Perhaps one of the most pleasing and at the same time surprising features of Indian architecture might be said to be the marvellous filigree screen (*jali*) in sandstone or marble that take the place of the glass windows of European buildings. Keene (*Stone Industries of Agra*) gives a very accurate and impressive account of the screens at Fatehpur Sikri (constructed, 1581 A.D.). "The outer screens" he says "are so minutely pierced that they actually look like lace at a distance and illuminate the mortuary chamber with a solemn half-light which resembles nothing else that I have seen." Colonel T. H. Hendley, C.I.E., discusses the uses of marble in Rājputāna in the following passages :—"Jaipur supplies most of Brahmanical India with its idols in white marble, plain or coloured and gilt; in red or black marble." "The purest white marble is brought from Makrána, a short distance from the Jodhpur side of the Shambhar Lake, but a much-liked white marble, often veined with blue, of a cheaper kind, is obtained from Raialo on the Alwar border, and is especially worked at Dausa. The stonemasons prepare in the summer enormous stocks of images which are brought by the brokers from Gujarāt (Bombay) and elsewhere after the rains and then sold by retail in the winter. The Makrána marble is worked at Jaipur, though sometimes very large idols are roughly hewn at the quarries to lessen expense of carriage. Baldeogarh on the Alwar border yields black marble, of which figures of animals, besides great idols, are made. The red marble from the same place is usually cut into the forms of camels and plates. All these marbles are employed in architecture, and in addition of late, green marbles from Ajmir. The boys learn to carve

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<i>Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)</i>	ALKALIS.
by making small images from soapstone. These sell readily among the poor."	MARBLE.
In Agra a fairly extensive industry exists in the preparation of screens, tables, fancy boxes, picture frames, plates, vases, etc., as also models of the Taj and other ancient monuments. These are mostly done in white marble inlaid with agate, carbuncle, carnelian, chalcedony, jade, jasper, lapis lazuli, topaz, turquoise and even with bloodstone, garnets, rubies, sapphires, etc. This art is supposed to have originated with the Taj (A.D. 1627-1658) and to have gradually declined until at the beginning of the 19th century it had disappeared. It is said to have been revived by Dr. J. Murray about 50 years later. It has flourished ever since, the goods produced in Agra being carried for sale by the traders in Indian artwares all over India.	Inlaid Marble.
(B) GYPSUM, PLASTER of PARIS and SULPHATE OF LIME, <i>Diet. of Econ. Prod., IV., pp. 195-97.</i> —This is the hydrous calcium sulphate which, when it occurs in an amorphous state, is called <i>GYPSUM</i> ; when in a more massive condition is <i>ALABASTER</i> ; and when in transparent crystals is <i>SELENITE</i> . On being calcined it parts with its water and then constitutes <i>PLASTER OF PARIS</i> . The powder thus produced on addition of water gradually sets and as it does so expands slightly. It is this property that has made <i>PLASTER OF PARIS</i> so exceedingly valuable for making casts and moulds. In India it is known by an extensive series of names such as <i>Kulnar</i> , <i>kurpûra-silasit</i> , <i>kârsi</i> , <i>sang-i-jerâhat</i> , <i>surma safed</i> , <i>makol</i> , <i>jirah</i> , etc. Plaster of paris is generally called as <i>Gach</i> .	GYPSUM.
	Alabaster.
	Selenite.
	Plaster of paris.
	Vernacular Names.
<i>Occurrence.</i> —In the <i>Madras Presidency</i> it has been met with abundantly, but in an impure form, in the cretaceous rocks of Trichinopoly. Masses of gypsum and crystals of selenite are occasionally found in the clays of Chingleput. In Nellore crystals of greater purity than those found near Madrás have been recorded as fairly prevalent.	Madras.
In <i>Bombay</i> selenite occurs in the marine deposits about Bombay and in Káthiáwár and in some parts of the Deccan. Very excellent gypsum is found in Cutch. In <i>Sind</i> deposits frequently 3 to 4 feet thick occur near the top of the Gajbeds of the Kirthar range. The Mud Gorge on the Harnai route to Quetta owes its intractable character to the circumstance that much sulphate of lime is there present and very largely in the anhydrite condition. This absorbs water and thereby expands 33 per cent. The adjacent materials are in consequence continuously displaced and the Mud Gorge may, therefore, be said to be in a state of constant change.	Bombay.
	Sind.
	Baluchistan.
In <i>Rájputána</i> , at Nagor in Jodhpur, a bed of gypsum probably not less than 5 feet thick has been worked to some extent. It is not	Rájputana.

ALKALIS.	<i>Alkalis, Alkaline Earths, Alkaline Ashes, etc.</i>
GYPSUM.	as a rule of good quality and is mined in a very crude fashion. While excavating a well at Falod, gypsum of a very pure quality was found but at too great a depth to be of much value.
Punjab.	In the <i>Panjab</i> (Bannu District) the mineral is found in Kálabágh and in Khasor but not utilized. The Kohát District contains gypsum in great abundance. Ball says "It might be obtained by open quarrying in any quantity but is not worked." The Salt Range possesses gypsum in enormous quantity associated with rock salt. The Spiti Valley contains gypsum of snowy whiteness.
United Provinces and Oudh.	In the <i>United Provinces</i> , deposits of gypsum have been reported as met with in Dehra Dun, Kumaun and Garhwál. Mr. C. S. Middlemiss (<i>Records Geological Survey, XXII, Pt. 2, 1889</i>) gives a full account of the gypsum of Nehal Nuddi in Kumaun. The " <i>Pioneer</i> " (<i>July 27th 1888</i>) announced that gypsum had been found at a locality some 19 miles distant from Haldwani, a station on the Rohilkhand and Kumaun Railway.
Burma	In <i>Burma</i> gypsum has been found but not in quantity to be of much commercial importance.
USES.	Industrial and Agricultural Uses. —For a great many years gypsum has been regarded as a <i>manure</i> of exceptional merit especially for leguminous crops and for certain soils. It has recently been found to vastly increase the yield of indigo so that a large demand seems likely to arise for gypsum. The reader should consult the observations already made (Page 120) regarding the use of this salt in destroying injurious alkalis and at the same time so modifying the physical conditions of the soil as to bring it into a culturable state. Gypsum might be viewed as an important constituent in the much admired manure known as "Superphosphates"—a manure that might be briefly described as prepared by the treatment of phosphatic minerals with sulphuric acid.
Manure.	
For Indigo.	
For Reh.	
Superphosphates.	
Plaster of paris.	
Lattice Work.	The next most important use for gypsum may be said to be the numerous methods of utilising plaster of paris. In 1852 Dr. Buist drew attention to the interesting fact that the Natives of Sind had, from ancient times, been in the habit of casting lattices and open-work screens to be used within houses to allow of free circulation of air. The Marwaris very cleverly make what might be called stained glass windows by taking two lattice screens, made of plaster of paris and of identical pattern, and placing between these fragments of coloured glass so arranged as to bring out the desired colour design. The screens are then firmly fastened together and the fragments of glass secured in their positions by a thin layer of liquid plaster being run over the lattice upon which the glasses have been arranged before pressing home on the top the second lattice.
Coloured Glass Work.	

Alkalies, Alkaline Earths, Alkaline Ashes, etc. (G. Watt.)

ALKALIES

In many parts of Rajputana and of the Punjab the walls and ceilings of palaces are richly ornamented, in arabesque design, by fragments of glass. These are silvered behind or backed with plated metal discs or with coloured tinfoil or they are painted on the surface and imbedded singly or collectively in wooden frames, within a plaster which consists mainly, if not entirely, of plaster of paris. This work might be described as a kind of mosaic and from the fact of pieces of glass (*shisháh*) being used has come to be spoken of as shish-mosaic. The famous *Shish-mahal* (the Palace of Glass) at Agra, the *Shish-mahal* at Lahore and the *Shish-mahal* in the ruined city of Amber (near Jaipur) are perhaps the best examples of this class of work. Mr. Kipling very truly says "The effect of the *shish* or mirror mosaic, though brilliant, narrowly escapes the charge of vulgarity," so that it is not much to be regretted that the art may be said to be hardly practised at the present day. Dr. Fleming in his "*Account of the Salt Range*," says the Natives use plaster of paris mixed with pure lime to produce their finest qualities of shining marble-like *chúnám*. **PLASTER OF PARIS** is also largely employed as a white-wash.

While it would thus seem that certain uses of plaster of paris have been well known to the Natives of India, for a considerable period at all events, a knowledge in the art of casting figures, ornaments and toys in that material would seem to be of comparatively recent date and to have originated with the Schools of Art. So late as 1885, while engaged supervising the preparation of life-sized statues or models of ethnological subjects that were required for the Colonial and Indian Exhibition, I experienced the greatest possible difficulty in inducing the Krishnagar modellers to substitute plaster of paris for clay. I procured a railway wagon load of gypsum from the Salt Range, had it fired in Calcutta and found that it yielded a most excellent modelling plaster and at a cheaper rate than I could purchase the imported article, which alone was then procurable in Calcutta. But my clay modellers struck work and I had to import others from Lucknow before I could induce the Krishnagar men to resume work. I mention this circumstance as showing the quality of the Indian plaster of paris.

Alabaster where met with is largely utilized in the manufacture of ornaments and toys. The dark green form procured from Garhwál is regularly made into elegant cups and saucers and even large bowls that are much admired by the richer Native gentlemen of Northern India. The same material, drawn from various sources, is to some extent utilized by the stone carvers in Agra and other centres of that industry. To a very small extent gypsum is used as cooling medicine in fever and when burned into plaster of paris it is sometimes employed as a substitute for lime in *pán*.

GYPSUM.

Arabesque
Ceilings.

Shish-mahal.

Plaster of
paris Casts.

Modelling.

Alabaster
Toys.Medicine.
Food.

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ALKALIS.

Alkalies, Alkaline Earths, Alkaline Ashes, etc.

STRONTIUM.
Production.

Celestite.

Sugar
Refining.
Strontianite.

Red Fire.

6. STRONTIUM and STRONTIA.—The oxide strontia does not exist in nature, but it may be produced by burning either the carbonate or the sulphate. *Celestite*, the sulphate of strontium, has been reported as met with in two localities in India, viz., in the Kirthar limestones of Sind and in the red clays of Surdag in the Salt Range. In the sugar refineries of the Continent of Europe the native carbonate (*Strontianite*) was formerly used in place of lime. (*Journal Soc. Chem. Industry, Nov. 1901, p. 1092.*) But this metal is chiefly known in India in the form of the imported nitrate which is largely employed in the preparation of red coloured flames in fireworks.

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1902—No. 6.

ÆSCHYNOMENE SP.

(SOLA.)

[*Dictionary of Economic Products, Vol. I., Æ. 559—65.*]

THE SOLA-PITH PLANT:

A REVIEW OF EXISTING INFORMATION.

By DR. GEORGE WATT, M.B., C.M., F.L.S., C.I.E.

ÆSCHYNOMENE ASPERA, *Linn.*; (*Fl. Br. Ind., II., 152*).

This is the *Shola* of Hindustani or as it is pronounced in Bengal the *Sola*—a word which has been still further corrupted into *SOLAR* by English writers and manufacturers. In order to distinguish this from the next species it is often designated in the various districts of Bengal and Assam as the *Bhât* (white or rice-like) *sola* or the *phul* (flower or soft) *sola*. It is also known in the other provinces by the following names:—*Korhela, kodhila, kathua, kurdhela, fulkur-dhela, khokhri, khakhra, kuhila* (or *pani*=water-*kuhila*), *shupra* or *hupra, botla, bhida, dhendas, dhendar pola, soal, sul, pangasaver* or *siver, dhendor, kagdia, jiluga bendu, jiluga, atunete, takke, suddai kirai, benda, pau-bin, thaw, thaung, etc.*

Habitat.—A floating bush, with sensitive leaves, found on land annually inundated or within the margins of tanks or lakes; throughout Bengal, the greater part of Assam, frequent in Burma and also present in South India, but represented in the other provinces by the next species.

Cultivation: Season.—It is not systematically cultivated but, after removal of the stems, in November and December, the upper portions with ripening pods are thrown on the water where they float until the seeds are self sown. The roots are also perennial and

TRUE SOLA
PLANT.

An Aquatic
weed.

CULTIVA-
TION
Season
Nov.—Dec.

Æ. 559-65.

ÆSCHYNOMENE SP.

The Sola-Pith Plant.

CULTIVATION.	produce an annual crop of shoots. These begin to appear in April and May, the flowers set about August and September and by February and March the pods are ripe and the pith-yielding shoots over-ripe. If left until the seeds mature the stem becomes dry, shrinks, discolours and a large cavern forms along the centre, which corresponds with the true or theoretical pith. While the <i>sola</i> can exist on the banks of tanks or lakes, above water level, it becomes reed-like, the shoots are then rarely thicker than the little finger and the plant is apparently unhealthy. It is essentially an aquatic species and normally grows in from 2 to 4 or 6 feet of water; the stem below swells greatly, in the middle third (it becomes perhaps 2 inches in diameter), in the lower third it tapers towards the roots or muddy bottom of the swamp, and in the upper third towards the portion that rises above the water level. It often grows in corners of rice fields and, where a demand exists for the pith, becomes a source of revenue and is thus more or less protected. Usually, however, it is viewed as a pernicious weed and is accordingly uprooted. It may generally be accepted as indicating the deeper portions of the fields—those that retain water more or less throughout the year.
Stem Shrinks.	
Swamp Cultivation.	
Appearance in Rice Fields.	
MANUFACTURES. PITH WORKERS.	Pith Manufactures. —In Bengal and Assam the workers in pith as a rule belong to the Hindu caste of garland-makers, the Malakars or Malis. They have usually acquired the exclusive and hereditary right to manufacture the garlands and decorations required by the families of a certain locality for marriages, festivals and religious ceremonials. The stems are cut into lengths of two or three feet—only the thicker portions being selected—and tied into bundles. After being stored until quite dry, the brown bark is first removed and the pith thereafter cut up in various ways according to the necessities of the article for which it is required. If, for example, intended for the manufacture of hats, caps or frames of pugries, it is split into thin sheets. For this purpose the stem is held in front of the operator and with a long sharp thin knife is stripped spirally, the knife being made to travel round and round within the thickness, until the whole stem is reduced to a sheet not much thicker than note paper. To perform this feat expeditiously requires great skill, since the slightest excess pressure will compress the pith and produce inequalities in thickness or sever the sheet into useless pieces. Hats, etc., are worked up on wooden or clay moulds of the required shape and size and, if honestly made, are built up layer upon layer of <i>sola</i> sheets, pasted one on the top of the other. By dishonest makers a large proportion of paper is intermixed with the pith thus adding greatly to the weight of the hat and lessening very materially its
Hat Making.	

Æ. 559-65.

The Sola-Pith Plant. (G. Watt.) *ÆSCHYNOMENE* SP.

insulating power (to the rays of the sun)—the property which makes the *SOLA-TOPI* superior to hats made of felt, cork or any other known material in the hat trade. In Assam the idols of *Manāsa* (*Monosa*, the Snake goddess) are made of pith: similarly in some parts of Bengal both Hindus and Muhammadans, during the month of August, worship a *sola*-pith idol.

If the pith be required for the manufacture of flowers or to be woven into mats, the debarked stalks are drawn between bamboos, fastened upright in the ground at various distances apart, or are flattened by means of smooth stones, a stone being firmly drawn over the top while the *sola* rests on a smooth stone floor. By either of these methods the pith is compressed and drawn out. It will retain the form thus given it until moistened, when it again expands. To make a flower the strips of *sola* are compressed in such a manner that in transverse section they are more or less triangular in shape and, along the surface corresponding to the base of the triangle, parallel lines are cut. To make a flower, strips of *sola* (prepared in the way indicated) are cut with a sharp knife transversely into very thin pieces. The pointed ends of the triangles are inserted into slits made on another stick of *sola*, intended as the stalk of the flower. When the required parts have been thus inserted into their places a brush, moistened in water (previously coloured green) is made to touch the outer whorl of triangles. These instantly expand and become the sepals of the rose or other flower. A brush, moistened in pink or other coloured water, next touches the inner whorls and these obeying the magician's wand expand into petals and are bent while still flaccid into the desired positions. The slits that were cut lengthwise along the compressed sticks of *sola* are now seen to open out into petaloid teeth. Stamens are formed of thin strips of pith, upon the extremities of which (from a coloured saccharine fluid) particles of sugar have been made to crystallise, thus forming glistening anthers. Floral buds are constructed of stained grains of rice fastened within green leaflets of *sola*. But to write a full account of all the simple and effective contrivances adopted by the pith-workers would occupy many pages. The few illustrations given must be accepted as denoting the high proficiency attained by these simple yet artistic artificers.

The three great centres of this art may be said to be Dacca for camellia-like large flowers; Mandalay for graceful sprays of small flowers; and Tanjore for models, such as temples, carts, etc. But all over India the malakars are to be found making marriage crowns (the *Mukut* or *Topar* of Bengal, the *maur* of Behār and *murial* of Assam) for Hindu brides and bridegrooms; the *Sehra* or bridal veil

MANUFAC-
TURES.

FLOWER
MANUFAC-
TURE.

Compression
of Pith.

Swell when
moistened.

Stamens or
Buds.

Centres of
the Art.

Æ. 559-65.

ÆSCHYNOMENE SP.

The Sola-Pith Plant.

MANUFACTURES.

or chaplet worn by Muhammadans ; the decorations for idols such as the *Chhar*, *Jhulan* and *Rahan* ; or the *Gerua* to be worn during the worship of *Satdeo* ; as well as children's toys, such as crude artificial flowers, fruits, dolls, birds, etc., all contain sola or are entirely made of that substance.

Local Manufacture.

Sola as a Tinder.

Some quarter of a century ago sola held a much higher place in the domestic life of the people of India than at the present day. It was then in universal use as a tinder ; a stick of sola burnt at one end was held in the hand alongside of a flint ; by a stroke of the steel a spark was conveyed to the ashes of sola and could be instantly blown into flame. The introduction of matches may be said to have driven sola tinder from the homes of even the poorest inhabitants of India, but sola still finds a place as a useful and convenient cork for medicinal and other bottles and as plugs to widen the perforations made in the ears to admit of large and still larger earrings. It is made into bottle cases within which bottles or other vessels may be placed so as to keep water cool. It is employed to line the tops of palankins and thus prevent the penetration of the sun's rays and keep the interior cool. It is also used for the lining of seats and cushions such as elephant pads, and in Bardua village in Nowgong, Assam, it is even woven into sleeping mats or *kats* as they are designated. By the Muhammadans it is utilized as a lining to the more highly ornate *Taziyas* used at the Muharram.

Bottle cases.

Mats.

MEDICINE.

Medicinal.—In surgery a compressed and pointed piece of pith may be inserted into the opening of a sinus or abscess or the rigid os uteri. It rapidly absorbs moisture and expands, thus widening the opening. Flat pieces much compressed and with a circular hole in the middle may be similarly used as corn plasters.

CHEMISTRY.

Chemical.—A long and interesting paper on the *Chemistry of Sola* by Hancock and Dahl will be found in *Chemical News of July 12th, 1895*. These authors show that the so-called pith is in reality the true wood of the plant and that the pith proper is the softer central core. They identify the so-called pith as a lignocellulose devoid of free aldehydic groups and characterised by colour reactions which show a close resemblance to the celluloses.

Lignocellulose.

FOOD.

Food.—By way of concluding this summary of the information available regarding the sola plant, it may be said that the **leaves** are sometimes eaten as a **pot herb**. From Hoshangábád comes the information that an **oil** is extracted from the **seeds** and which is used in the treatment of cramp and pain in the side.

Pot-herb.

TRADE.

Trade.—There is practically only a local demand for **SOLA-PITH** and in its unmanufactured condition it is hardly if ever exported. The best quality is obtainable in Bengal and from there is carried all

The Sola-Pith Plant. (G. Watt.) *ÆSCHYNOMENE* SP.

over India. The manufacture of *SOLA-TOPIS* appears to have originated in Calcutta. The name *top* or *topi* is Hindustani in origin and occurs all over India. The expression *TOPIWALA* which was first very possibly given to the Portuguese, became in time applicable to all Europeans and simply means "hat-wearers." It was specialised at a much later date into the hats made of pith and, as suggested, these in all probability first made their appearance in Bengal. To this day the centre of the trade may be said to be in Calcutta and, although all over India and even in Egypt and Europe, these hats may be purchased and bear the names of local makers, the bulk of the frames are made in Bengal and are exported in that condition to be covered and finished off by local traders. (*Fl. Br. Ind.*, II., 151.)

Æ. INDICA, Linn.

Habitat.—This is a much less aquatic form than the preceding. It occurs throughout Behár, the United Provinces of Agra and Oudh, the Central Provinces, Berár, the Panjáb, Rájputána, Sind, Bombay and South India. It is also met with in Bengal, Assam, and Burma, but in these provinces always on the margins of canals and rivers, above water level, or in low-lying land that is but temporarily flooded. It is a taller, more bushy plant, than the preceding species and as a rule forms harder and more woody stems.

It is known by the following names:—*Kat* or *kath* (=hard) *sola*, *kukri*, *papri*, *khukhundi*, *kat-kurdhela*, *kothela*, *chauchi-sola*, *khukhri*, *bendu*, *tige-jiluga*, *mullu-jiluga*, etc. It is the *kuhila* of Assam generally, the *pani*-(=water) *kuhila* being the preceding species: it is the *kathia dhendor* of the Central Provinces, *Æ. aspera* being the *kagdia-dhendor*. The *chirmilli* or *sirmilli* of these Provinces is probably *Sesbania* and not *Æschynomene*.

Manufactures.—These and such like names contrast this with the other species, the present being the hard *sola*. It is, however, used for most of the purposes to which the soft *sola* is put, though being harder it cannot be so easily cut nor made into such beautiful thin sheets. It is accordingly unsuited for flower-making; but at Sheikhpuri, a village in the Roorki District, a large trade has recently been developed in the manufacture of *SOLA-TOPIS* from this form of pith—a surface dressing only of Bengal-pith being given. The *SOLA-TOPIS* of Upper India are accordingly now very largely derived from Roorki. Being a cheaper form of pith it is also the quality most generally employed as floats for fishing nets, for fishing baskets (*khaloï*) and fishing rafts, and also for supports to persons who have to swim across large rivers, etc. It is believed, moreover, to be more durable in water than the soft *sola*. It is extensively utilized in making *gadis* or elephant pads. Since it is an abundant weed it is a useful fuel and has the reputation of being of special value in firing pottery. The

TRADE.

Sola-topis.

A Calcutta Trade.

ÆSCHY-
NOMENE
INDICA.

A Marsh Weed.

Vernacular Names.

Manufactures.

Roorki.

Sola-topis.

Floats.

Padding for gadis.

Fuel.

Æ. 559-65.

ÆSCHYNOMENE SP.

The Sola-Pith Plant.

ÆSCHY-
NOMENE
INDICA.
Gun-powder.
Trade.

Distinctive
Character-
istics.

SOLA-
SUBSTI-
TUTES.

Manipur
Sola.

Angami
Naga Sola.

A Cheap
Sola.

Shan Sola.

charcoal made of it is highly prized in the manufacture of gun-powder and fire-works.

Trade.—No information can at present be furnished on this subject, but it may be explained that the pith of *Æ. indica* may be recognised by the circumstance that the stem is curiously striated on the thin bark and has wart-like formations along the striations. The central pith is always present in the form of a hollow surrounded by a slightly hardened layer. In *Æ. aspera*, the bark is not striated, the stem, unless when over-ripe, is quite solid, very soft and of a pure white colour.

SOLA-SUBSTITUTES.—The following are the chief plants, and localities, where used, of the substitutes for *SOLA*, communicated to me in connection with the above mentioned correspondence :—

ARALIA ARMATA, *Seem.*, The *Bam-* (high land) *kuhila* of Sib-sagar, Assam.

CASSIA MIMUSOIDES, *Linn.* (*Dict. Econ. Prod. II.*, 220). The *Bam-kuhila* of Jorhát, Assam.

CEPHALANTHUS OCCIDENTALIS, *Linn.*, The *Chonggang* of Manipur, Assam, used in the manufacture of flowers and other decorations.

HEPTAPLEURUM HYPOLEUCUM, *Kurz.* (*Dict. Econ. Prod. IV.*, 222). This is the *Tirruhu* of the Angami Nagas, the pith of which is used in the construction of a girdle worn around the knot of hair and as the ear-ornaments donned during the cold season *gennas* or *pujas*. It is also employed in the construction of a sort of halo placed on the head during special occasions.

MIMOSA PUDICA, *Linn.*, (*Dict. Econ. Prod. V.*, 248). The *Lajoni* of Araria in Purnea, Bengal, used as floats.

PENTAPETES PHENICEA, *Linn.*—The *Kaya-sola* of Midnapur.

SESBANIA PALUDOSA, *Prain*, (*Dict. Econ. Prod. VI.*, Pt. II., 542). In many districts of Bengal, the United Provinces and the Central Provinces this bears the same vernacular names as have been given for *Æschynomene indica* more especially *kath-sola*. The pith of the two plants is certainly very much alike, only that the term *kath* or *hard* is even more appropriate to the present plant than to *Æ. indica*. It is the *Jainti* of Purnea, a district in which both plants grow abundantly and are separately distinguished. For all the ordinary purposes, such as floats, padding of elephant *gadis*, lining to palankins, etc., the pith of this plant may be used in place of the true sola.

SONNERATIA ACIDA, *Linn. f.*, (*Dict. Econ. Prod. VI.* Pt. III., 275). The *Lama-paw* or *Nyan-tha-paw* the "inferior-wood-sola" as the last name denotes; the wood is often (in Rangoon) used in the manufacture of toys, etc., in place of sola.

TREVESIA PALMATA, *Vis.*—The *Maitang* of the Shans. Pith sometimes made into artificial flowers and other decorations for religious offerings and mostly in zig-zag patterns. Leaves boiled and eaten as a sort of soup.

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AGRICULTURAL LEDGER,

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(Vegetable Product Series, No. 72.)

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1902—No. 7.

ASPHODELUS TENUIFOLIUS.

(SYN. A. FISTULOSUS.)

[*Dictionary of Economic Products, Vol. I., A. 1581 a.*]

Asphodelus tenuifolius—An Indian Famine Food.

By A. GHOSE.

Early in the present year I was asked by the Officiating Reporter on Economic Products to the Government of India if I would analyse the seeds of **Asphodelus tenuifolius** and report upon their value as a food; hence the following short paper. The material for examination was collected in the Hoshiárpur district by him and by Mr. R. Sykes, the Director of Land Records and Agriculture, Panjáb.

Asphodelus tenuifolius is a small weed of the natural order LILIACEAE, excessively common in Northern India, extending right through the warmer parts of Western Asia, Europe and North Africa to the Atlantic Ocean. It is hardly to be found in India, South of Gujrát. It loves sandy soils and is almost as common as the wheat stalks on some of the poorer cultivated lands in the Southern Siwálíks; in the plains of the Panjáb it is very prevalent.

The European form of the plant is somewhat larger, and on this account is sometimes distinguished as a separate species under the name of **Asphodelus fistulosus**.

The vernacular names of **A. tenuifolius** in India are *piazi*, *bokát* or *bokát*, and the seed is known as *binghar bij*.

In India, plant and seeds are alike eaten in time of need. In the last famine, the seeds were much eaten in the Jálandhar district. Mr. Sykes has sent to the Indian Museum specimen cakes made of

INTRODUC-
TORY.

DISTRIBU-
TION.

VERNACULAR
NAMES.

Uses
Famine Food.

A. 1579.

ASPHODELUS
tenuifolius.

Asphodelus tenuifolius

USES.

the seeds mixed with wheaten flour. Stewart (*Panjab Plants*, p. 234) puts forward the view that this is the plant which Griffith describes the camp-followers as eating, when in 1839 the provisions of the Kandahar force ran scarce. Innes in his *List of Jungle Products used as Famine Foods* (1896-97) has named it as boiled and eaten as a vegetable in the famine of 1896. It is said to be ordinarily cooked and eaten by the inhabitants of the Bijnor district : and in the Panjab its seeds are given to pigeons.

Glue.

The plant grows like an onion with a small bulb and like the onions is very mucilaginous. The mucilage occurs in special cells which have been investigated by Lanza (*Malpighia* IV, 1890, p. 145), and from its occurrence the plant finds a peculiar use near Damascus, where it is abundant, and where something analogous to the "British gum" which is prepared from potatoes, is made by grinding the bulbs into a paste for the use of book-binders, shoemakers, etc., (E. D. Smith, *Dictionary of Economic Plants*, p. 28). Landerer, a French Chemist, found it possible from both *Asphodelus tenuifolius* (*fistulosus*) and *Asphodelus racemosus* to prepare an excellent glue by washing the bulbs with water, drying them, grinding them and mixing the resulting powder with water. (*Watts' Dictionary of Chemistry*, Vol. I)

NATURE OF
SEED

Asphodelus tenuifolius in India ripens its seeds in February, March and April months when, if famine conditions exist, the scarcity is growing intense ; it is then that the black angular seeds may be collected to supplement the available supply of food. They are produced in considerable abundance and are $\frac{1}{8}$ " in length and about $\frac{1}{16}$ " in diameter, three to each pod. The shell adheres very tightly and they cannot easily be husked. When pounded—shell and all—in a mortar the result is a rather greasy black paste.

Analysis.

The following analysis which I made shows the seed to be an oil seed :—

Moisture	.	.	.	.	.	.	.	7'40
Oil	.	.	.	.	.	.	.	25'25
* Albumenoids	.	.	.	.	.	.	.	25'95
Carbohydrates	.	.	.	.	.	.	.	17'32
Crude fibre	.	.	.	.	.	.	.	19'78
† Ash	.	.	.	.	.	.	.	4'30
TOTAL								100'00
* Containing Nitrogen	.	.	.	.	.	.	.	4'15
† „ Sand	.	.	.	.	.	.	.	'38
† „ Lime	.	.	.	.	.	.	.	'548
† „ Phosphoric Acid	.	.	.	.	.	.	.	'49

A. 1579.

An Indian Famine Food.

(A. Ghose.)

ASPHODELUS
tenuifolius.

Extracts from the seed were tested for alkaloids, but gave no reaction. The usual test with iodine solution failed to indicate the presence of starch and no sugar could be found.

The analysis shows that the seed is empirically by no means innutritious. It is, however, officinal in the Lahore bazars and is apparently diuretic in action. Indeed Dioscorides, who flourished about 80 B.C., recommended the plant as a diuretic; and the seeds share this property with the bulb and leaves. It is a property possessed by the allied onions, squills, etc., and is not really detrimental to its use as food.

Examination of the oil.—A weighed quantity of the powdered seed was extracted in Soxhlet's apparatus with dry ether, and a clear oil was obtained after the expulsion of ether and moisture. It was reddish yellow in colour and possessed a peculiar smell rather suggestive of mustard oil. Its saponification value was 108.72.

To test its quality as a drying oil a clean glass plate was coated with it and left exposed to the air at the temperature of the Laboratory. This was found to be perfectly dry on the third day at the end of 54 hours. It did not become sticky at the time of drying. To further test the drying quality five grams of "white lead" were taken and mixed with 5 drops of the oil. Zinc oxide of the same weight was mixed with ten drops of the oil. Two glass plates were coated with these pastes with the following results :—

	1st hour.	18 hours.	24 hours.	42 hours.
1. White lead coating	Very sticky and tacky	Dry.	Perfectly dry.	
2. Zinc oxide	"	Very sticky.	Sticky	Dry.

From the above facts it appears that the oil is a good drying oil.

The French have found that an alcohol can be prepared from Asphodel bulbs, and samples were exhibited in the Paris Exhibition of 1855.

In the same Paris Exhibition with the samples of alcohol were exhibited specimens of card-paper, cards and writing papers of various qualities, manufactured from the leaves and stalks of the plant mixed in various proportions with rags and common paper stuff. However, since that date, little has been heard of **Asphodelus tenuifolius** either as paper-material or for the preparation of alcohol.

NATURE OF
SEED.

Medicinal.

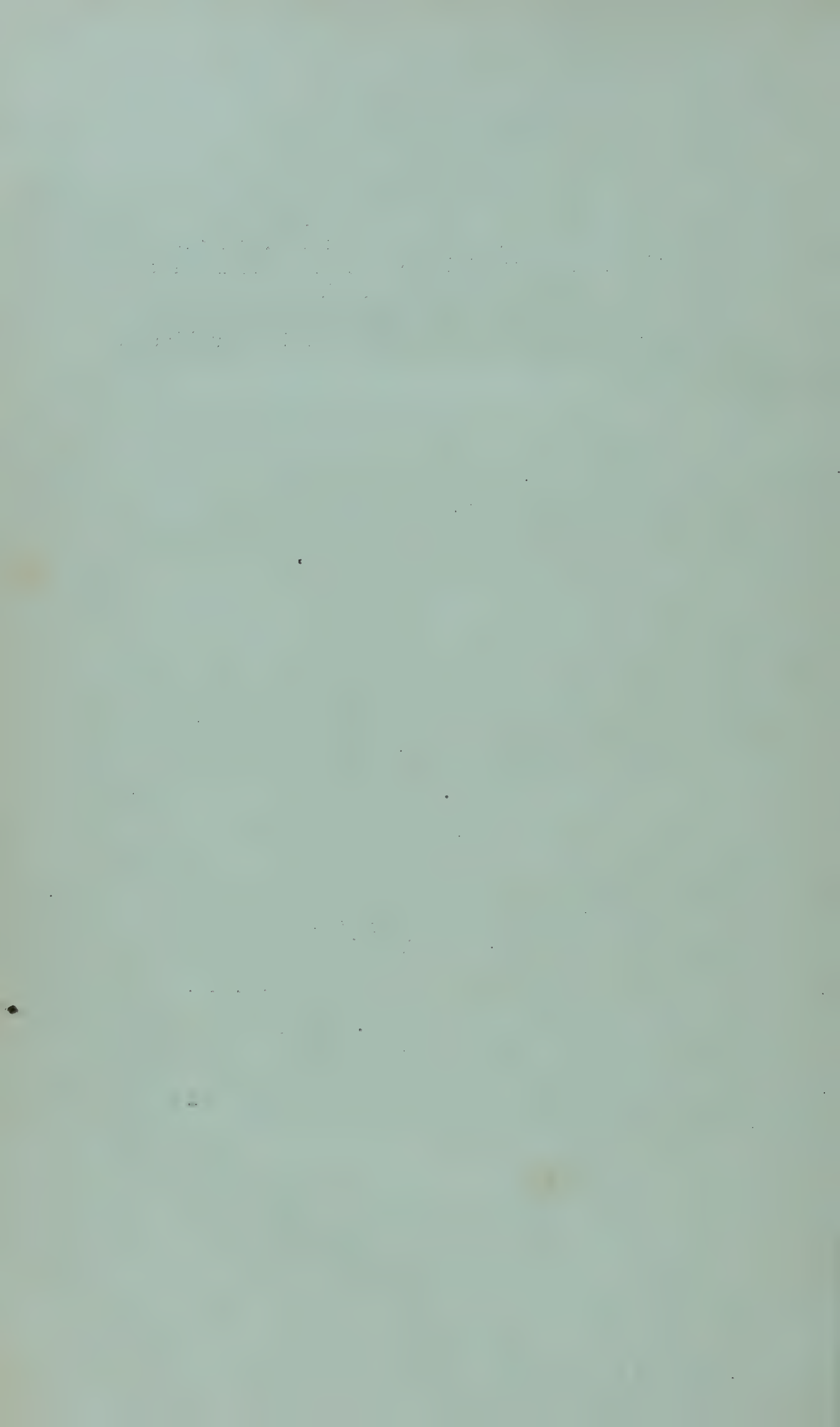
NATURE OF
OIL.

Alcohol.

Paper
making.

A. 1579.

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